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W. G. FARLOW.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF VEGETABLE PATHOLOGY.

PERIODICAL BULLETIN. Vol. 6.

Prof. [illegible]

THE

JOURNAL OF MYCOLOGY:

DEVOTED ESPECIALLY TO THE STUDY OF FUNGI

IN THEIR RELATION TO PLANT DISEASES.

EDITED BY

THE CHIEF OF DIVISION AND HIS ASSISTANTS.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1891.

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1891

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U. S. DEPARTMENT OF AGRICULTURE.

SECTION OF VEGETABLE PATHOLOGY.

QUARTERLY BULLETIN. MARCH, 1890.

Vol. 6. No. I.

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VOLUME 6, No. 1. } JOURNAL OF MYCOLOGY. { ISSUED May 14, 1890.

EDITED BY

THE CHIEF AND HIS ASSISTANTS.

CHIEF,
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ASSISTANTS,
EFFIE A. SOUTHWORTH. DAVID G. FAIRCHILD. ERWIN F. SMITH.

RECENT INVESTIGATIONS OF SMUT FUNGI AND SMUT DISEASES.

AN ADDRESS DELIVERED BEFORE THE SOCIETY OF AGRICULTURISTS OF BERLIN, FEBRUARY 17, 1888.

BY DR. OSKAR BREFELD,
Full Professor of Botany in Münster i. W.

[Translated from *Nachrichten aus dem Klub der Landwirthe zu Berlin*, Nos. 220–222, by Erwin F. Smith.]

GENTLEMEN: About four years ago, in January, 1884, I found opportunity in this place to report the new researches which I had completed upon the smut fungi, the *Ustilagineæ*. To this first communication I will to-day add a continuation explaining the results which I have obtained since my last address.

In nature the smut fungi live as parasites, in a multitude of forms. We find them universally distributed on the most dissimilar plants, but most frequently upon our cultivated plants and among these, especially, upon the different cereals. The usually striking and ruinous destructions which they produce in the host plants, and especially in the fruit-bearing portion, the spikes and panicles of grain, have been known and feared by farmers for a long time, under the name of smut diseases, or the phenomena of grain smut. The grain smuts belong without doubt to those plant diseases which operate most destructively, in that they destroy the chief aim of cultivation, the grain itself. For this reason first of all they have a very just claim to the most exact research for their recognition and prevention.

As a matter of fact, researches on the smut fungi and observations and experiments on the appearance and prevention of smut diseases have been made repeatedly for a long time and have often claimed

attention. Keeping step with further knowledge and experience in mycology they are always taken up afresh whenever any new suggestions or new views for further enlightenment open up, and whenever new methods of research show new points for attack.

In this way, then, my researches on the smut fungi and diseases, begun about eight years ago, were only the natural continuation of the labors of earlier authors; except that they were accompanied by other and fresh thoughts and supported by methodical expedients such as previously had not found employment, nor, indeed, could find it. They were begun after a long stand-still in observations on smut fungi and smut diseases, and when renewed experiments with the worn-out thoughts and methods would give no new and substantial results.

Till my experiments everybody proceeded upon the supposition that the fungi existing parasitically in nature found their natural conditions of existence only upon their hosts, and therefore that the different smut fungi could live and grow only upon the different but definite and restricted host plants, on which they were observed in the open air. Accordingly it was very evident that experiments and observations must be confined to the host plants; that in order to investigate the connection of fungus and disease, the fungous germs, found on the host plants, consequently the smut spores, must be sowed again upon the host plants and their development followed. The idea was so simple and natural that candid minds did not suspect the confusion of perception and judgment which this thought naturally carried with it.

Upon the host plants the smut spores find, first, only moisture for their development, consequently they must germinate on the surface of the plants just as they germinate in a small drop of water. Now, germination experiments with smut spores in water have shown most convincingly that the spores in many cases, *e. g.*, in corn smut, do not germinate; that in other cases they germinate only in small numbers and very imperfectly, *e. g.*, in oat smut and millet smut. From these negative or at least imperfect results of germination in water, which results were to be observed in just the same way upon the surface of the host plants, the universal distribution of the fungi in question and of the smut diseases in grain could be explained only very imperfectly or not at all. Nevertheless, these explanations gave satisfaction, the rudimentary consistency of facts was regarded as complete, and to no mycologist did it occur that any one would succeed in acquiring new information or in making a very important advance in the knowledge of smut diseases.

My culture methods for the investigation of fungi, were slowly and painfully established and brought to gradual completion during the long period of more than sixteen years, and meanwhile put to use, alike in the minute schizomycetes and the great mushrooms, in the simplest as well as the most highly developed fungous forms, with similar trenchant results for knowledge of the developmental history of fungi. These

led me, in their further perfection, gradually to results which made the difference between fungous forms that maintain themselves as parasites on living plants and animals, and such as live only as saprophytes on dead organic substances, appear less sharp than, according to the common state in nature, it was believed to be. I succeeded artificially, with my nutrient solutions, in growing fungous forms as luxuriant as were to be observed in nature on the host plants, and in some cases much more luxuriant, *e. g.*, *Peziza ciborioides* and *P. sclerotiorum*, which in nature are found living on clover and rape; also, *Sphacelia segetum*, the fungus of ergot, and many others. This itself led me to considerations on *the nature and reality of parasitism and on the way in which the various parasitic phenomena in nature might come about.* These observations always led only to the one reasonable conclusion, *that parasitism can be nothing else than a form of existence which has become more or less suited to the fungus according to the length of time, and differently and specifically adapted to it in each individual case, but which, for all that, has become by no means constant.* It was only the natural consequence of these trains of thought, based upon observations in nature, and upon the results obtained in my culture experiments, to draw this conclusion: *Even in the most distinctly marked cases of parasitism, in which the fungus is found only on given plants or even on particular portions of these, nothing else is before us except the furthest extended phenomena of the same adaptation, which by its more developed form produces the OUTWARD APPEARANCE, as though the natural conditions for the existence of these parasites were given exclusively in the living substratum, consequently in the particular host plants, or special portions of these, and as though every other way of life and growth were altogether excluded.*

And by this outward appearance all mycologists were obviously captivated, until my investigations. No botanist had thought of critically examining the essential nature of parasitism, of following out naturally the sole possible origin of parasitic phenomena, and of making it clear in what way the whole multitude of its variations is simply and naturally subordinate to one unifying thought, *a thought which included in itself not only the possibility but also the probability that fungi living parasitically—at least the greater part, if not all of them—can live outside of the host plant.*

When, almost ten years ago, I gave publicity to my views on parasitism along with my culture methods, and at the same time expressed strong confidence that unquestionably it must be possible artificially to cultivate most, if not all, parasitic fungi, my views remained not only generally unconsidered, but were in special cases, in the *Botanische Zeitung*, even scornfully criticised. This circumstance shows, as no other, the confused judgment of mycologists upon parasites and parasitism, and enables one to measure clearly the difference between the old sterile ideas and the new fruitful thoughts. Only this confusion of ideas, which must be plain upon considerate reflection, could have prevented

the earlier mycologists from at once *striking into the broader way for the investigation of parasites, the method of cultivation in artificial nutrient solutions instead of in mere water.*

As great as the fundamental difference in ways of thinking and methods which separates the earlier and the present investigations, so great is the difference in the results obtained, as I shall now show more explicitly in further experiments with the smut fungi.

Even in my first address on smut fungi and smut diseases, in 1884, I communicated important and unexpected results which I had then reached in cultivating different smut spores in artificial nutrient solutions.* While *in mere water* the smut spores either did not germinate, *e. g.*, the spores of corn smut, or germinated only scantily and concluded their development with the formation of a short germ tube (promycelium) and a few germ cells (conidia or sporidia); the same spores germinated *in nutrient solutions* without exception, the germ tubes produced conidia in inexhaustible abundance,† which only grew out into germ tubes when the nutrient solution was exhausted. The conidia were of definite shape and size, therefore specific for the individual forms of the smut fungi. In a number of forms they were produced *under liquid*, *e. g.*, in *Ustilago carbo*, *U. cruenta*, *U. maydis*, which are known as oat, millet, and corn smut; in other forms they were produced above the liquid *in the air*, *e. g.*, in the stone smut of wheat, *Tilletia caries.* In this fungus and the forms related to it there grew further in nutrient solutions, out of the conidia derived from spore germination, large, richly branched mycelia, which again produced the same conidia in unlimited abundance as short lateral shoots; *there arose, in fact, mold-like turfs*, which were again produced out of the new-formed and again new-sowed conidia, always in the same manner and abundance, so long as the culture was maintained in the nutrient solution. In oat, millet, and corn smut, and forms closely related to these, the further development of the conidia produced by spore germination under the nutrient solution continues not mold-like, but quite otherwise. *The conidia of definite size and shape produced on the short germ tubes of the smut spores multiplied in just this size and shape by direct sprouting at definite places, and that always at both ends, in a rapid manner, without limit.*

Furthermore, the sprout-colonies of conidia which were so produced,

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*Additional cultures with parasites selected at random resulted in showing that in almost all cases maintenance outside of the host plant is easy to accomplish; even the lichen forming *Ascomycetes*, which live on and with different algæ, representing the so-called lichens of nature, could be easily cultivated "without algæ" in my nutrient solutions with the help of my culture methods, as final valid proof that lichens are nothing but a number of *Ascomycetes* which live parasitically on different algæ. *Vide* Möller, *Kultur flechtenbildender Ascomyceten ohne Algen.* Arbeiten aus dem botanischen Institute in Münster i. W., 1887.

† For those who only read my address and have not seen the accompanying illustrations on the wall charts, I refer to the tables in my book *Brandpilze* I.

and which easily separated into their individual members, enabled us to recognize in the different forms of smut fungi, to which they belong as stages of the development, a different but always definite and typical appearance, depending on the form and size of their conidia. Thus, for example, the sprout conidia in oat smut (*Flugbrand*) were produced from the long egg-form conidia of this smut; the sprout colonies of the corn smut were made up of the longer somewhat spindle-form conidia, peculiar to this smut fungus; the sprout aggregations of the millet smut had the narrow spindle form of the conidia of this fungus. Even in the different species of the smut genus *Ustilago*, investigated four years ago, there were found "as characteristic stages of the development," just as many specific and different sprout forms as are found round to elongate conidia of the various sizes.

In their appearance and in their growth by sprouting these aggregations of conidia in the smut fungi are also similar to the large number of those long-known fungous forms which, from their characteristic growth and increase by so called sprouting, it has been thought necessary to consider as specific forms, and also to specially distinguish as SPROUTING FUNGI. They also show themselves fully consonant with the previously known sprout fungi in that, like them, they continued sprouting indefinitely, so long as they vegetated in congenial nutrient solutions; and in that they always remained in sprout form, consequently staid sprouting fungi, and passed over into no other form, only at most, not always, pushed out into germ tubes, when the nutrient solutions were exhausted. The sole difference, a negative one, however, between the newly discovered sprout forms of the various smut fungi and the fungus forms previously passing current as "sprout fungi" par excellence, which forms we encounter so very frequently in our nutrient solutions, and designate briefly as "mold (Kahm) fungi," or "yeast fungi," could be expressed only as follows: We now know the yeast or conidia-sprouts of the smut fungi not simply by their endlessly continued sprouting in nutrient solutions; we know further through the first beginnings of the culture, the sowed smut spores, that they represent nothing but special stages of development of the various smut fungi from which they were evolved; so far we do not know this of the other sprout fungi, because they have not yet been investigated from the right points of departure. From this it follows, further, that we do not judge correctly when we hold the so-called sprout fungi for independent fungi, as has been done hitherto, upon the fact alone of their endless sprouting in nutrient solutions. From the definite form of their individual members and the definite places of sprouting these must rather pass for nothing else than simple conidia sprouts of other fungi, consequently for stages in the development of higher fungous forms, which when sprouting in nutrient solutions behave like independent fungi, in just the same way as do the sprout-conidia of the smut fungi. *Artificial culture of the different smut fungi in nutrient solutions brought along then in its train as a side issue the obvious solu-*

tion of another still open question, the sprout-fungus or yeast question. It could only be considered as a simple matter of time when, through the spore culture of the remaining higher fungi, further and supplementary proof would be brought as to which forms among these fungi include in their course of development the still remaining sprout fungi which do not belong to the various smut fungi. The investigations in this direction have meanwhile, it may be mentioned in passing, already led to the most far-reaching results in the most diverse Ascomycetes and Basidiomycetes.

Aside now from the forms of smut fungi which, like *Tilletia*, produce large mycelia with conidia in nutrient solutions, and aside further from the forms which, like *Ustilago carbo*, *U. cruenta*, and *U. maydis*, produce conidia in endless sprouting in yeast form, there are still *other forms which produce conidia on the conidiophores of the germinating smut spores (the promycelia), which do not sprout directly, but always first grow out again into new promycelia until the conidia sprouting begins anew on these.* Here belong, for example, *Ustilago longissima* on *Poa aquatica*, and *U. grandis* on *Phragmites communis*, with many-celled promycelia, and *U. bromivora* on *Bromus secalinus*, with typical two-celled promycelia.

Finally, forms were also discovered, as for example *Ustilago Crameri* on *Setaria*, *U. hypodytes* on *Elymus arenarius*, etc., the *smut spores of which, germinating in nutrient solutions, produce no conidia, but only sterile germ tubes, that grow into richly-branched mycelia, which in turn also remain free from conidia.* Here afterward the single threads pushed far out, stolon-like, and abjointing, constituted, in place of the absent conidia, the richly increased mass of germs present in the nutrient solutions.

In short, these are the most essential results which the cultivation of the spores of the various smut fungi in artificial substrata, in nutrient solutions (therefore outside of the host plants, where they are found in nature) had given four years ago. The number of forms the cultivation of which was tried in nutrient solutions then amounted to more than twenty. As supplementary, I have extended the cultivation to an additional twenty forms, some of which brought to light similar peculiarities as in the first series, *e. g.*, in the genera *Schizonella* and *Tolyposporium*, which produce sprout-conidia; while others yielded new and supplementary facts, the special communication of which however,* as well

* Only incidentally I will state for example that the genus *Neovossia* and species of *Urocystis* behaved the same as *Tilletia.* Of the recently investigated forms of the old genus *Ustilago,* which in its present extent is wholly untenable, a number behaved the same as *Ustilago carbo,* and produced sprout-conidia of various shapes; others, *e. g.*, *U. caricis, U. subinclusa,* and *U. echinata,* germinated in a specific manner with the production of little conidiophores bearing air conidia similar to *Peronospora. Ustilago Vaillantii* agreed with the type of *U. longissima; U. hordei,* a recently distinguished form on *Hordeaceæ,* produced large, sterile, *e. g.*, conidia-free, mycelia, like *U. Crameri,* etc.

as the conclusion I have reached as to the morphological value of smut spores and as to the natural position of the smut fungi in the system of fungi, will be omitted here because they possess a strictly botanical scientific value, but do not directly contribute to the understanding of smut diseases, and their propagation, subjects now specially in question.

From the ease and luxuriance with which these cultivated parasites, vegetated and fructified in the nutrient solutions, with most abundant increase of their germ cells in just the same way as any other fungous forms occurring in nature as saprophytes, the conclusion followed almost of itself that smut fungi can also vegetate in nature on dead substrata like all other saprophytes, and that, although invisible to the naked eye, they here run through just the same forms as were found in the nutrient solutions and have just been described. This conclusion found still further support in the fact that I had used as nutrient solutions and nutrient substrata for the smut fungi the entire series of media, the composition and compounding of which I had given in detail in my *Culture Methods for the Investigation of Fungi* and had ascertained as suitable for the cultivation of saprophytic fungi, especially extracts from the fresh dung of our domestic animals, in which the development of the smut fungi took place with the same ease as all other saprophytes which were cultivated therein. The wide-spread occurrence of the most various yeast conidia in the dung of herbivorous animals, conidia which are in no way different from those of the investigated smut fungi, was in accord with this conclusion, and further experiments by sowing smut spores in fresh dung not too wet proved directly the increase of the germs in the fresh dung substances of the earth. Finally, the long known and uniform statements of husbandmen that their grain was especially subject to smut when they had impregnated the field with fresh dung found its equally simple and natural explanation in the now actually established increase of smut germs in the fresh dung.

Instead of smut spores almost incapable of germination in water, *e. g.*, corn smut; instead of only scattering and rudimentary spore germinations in mere water, *e. g.*, oat smut, from the activity of which, according to the knowledge of the time, the occurrence of smut and the spread of smut diseases could only be derived, there was now brought to light through the new discoveries and their consequences, an entirely new and rich vegetative condition of smut fungi. This made the question not one of exclusive parasites and their exclusive development on the host plants, but revealed, as it were, a most productive *center of infection*, *outside of the host plants*, for the propagation of smut diseases; a center of infection in which are operative not the few weak germs of water germination but an abundance of conidia capable of vigorous germination—conidia which can grow out easily into long germ-tubes and reach and attack the host plants.

However extremely probable or wholly self-evident it may now seem to have been from the beginning that germs of smut fungi, developed

in nutrient substrata of all sorts, might actually produce the smut diseases in the host plants; however convincing the experience of husbandmen on the relations of fresh dung to the appearance of smut diseases in grain,—the described results of artificial cultivation being also consonant—these alone do not amount to conclusive proof, but remain probabilities with which we can not be satisfied. *The new investigations of smut fungi, which began with the cultivation of the parasites outside of the host plants and which with the results here attained are half exhausted, will not be conclusive and exhaustive for the ætiology of smut diseases until the supplementary half is appended, until through various and rationally conducted infection experiments it is actually shown in what way and under what circumstances the richly multiplied germs living saprophytically outside of the host plants attack the latter and produce the smut diseases, how and in what places the germs penetrate into the host plants, and how within these, widely diverging from the transformations outside of the host plants, they are changed into smut spores.*

And now, for these infection experiments, the easy maintenance of smut fungi in any sort of nutrient solution and the subsequent endless increase of their germs, offered an inexhaustable source for the production, at will, of an infective material no less fresh and vigorous than capable of attack—a material, immediately and easily available in all possible variations, never before used, and admirably adapted for the artificial production of smut diseases in the host plants.

(*To be continued.*)

ON THE EFFECTS OF CERTAIN FUNGICIDES UPON THE VITALITY OF SEEDS.

A. A. CROZIER.

The influence of various chemicals upon the germination of seeds is but little understood. Many which have a fertilizing effect when applied in small amounts to the growing plant are injurious when a strong solution is applied to the seed. There is evidence, on the other hand, that many substances when applied to the seed will hasten germination and increase the vigor of the young plants. An account of some of these is given by Prof. L. H. Bailey, in Bulletin 31 of the Michigan Agricultural College.

The following experiments were made with blue vitriol and copperas at the Iowa Experiment Station in 1889:

First, a rough test was made with a strong solution of blue vitriol, a teaspoonful in half a saucer of water. Corn was soaked in this twenty-four hours, and another lot soaked in pure water the same length of time, and both lots planted in soil in the greenhouse May 11. Examination was made daily with the following results, the figures showing

the number of plants which had appeared above the soil on the given dates, 100 seeds of each having been planted:

I.—*Blue vitriol upon corn.*

Date.	Twenty-four hours.		Date.	Twenty-four hours.	
	Water.	Blue vitriol.		Water.	Blue vitriol.
May 16	57	5	May 24	98	85
17	96	45	25	98	86
18	97	52	26	98	86
19	97	56	27	98	86
20	98	71	28	98	87
21	98	77	29	98	87
22	98	79	30	99	87
23	98	80	31	99	89

The above table shows that the treatment with blue vitriol prevented the germination of some of the seeds and greatly retarded the germination of most of the others. Many of the plants from the seeds treated with the blue vitriol came up feeble, with leaves which appeared as though scorched. On June 7, a part of these plants had become healthy, but they were as a whole much smaller than those from the seed soaked in water only. The set treated with vitriol contained twenty-eight plants, which were notably weak, and the other set but three weak plants.

The next trial was with a solution of 10 gallons of water containing 5 pounds of blue vitriol (see Circular 5, of Sect. Veg. Path. U. S. Dept. Ag., p. 5). The seeds were placed in the solutions on May 28, and allowed to remain for three different periods before planting. Examinations were made at the dates indicated, the figures showing the number of plants which had appeared above the soil from time to time. One hundred seeds were planted in each case as before.

II.—*Blue vitriol upon corn.*

Date.	Ten minutes.		Five hours.		Twenty-four hours.	
	Water.	Blue vitriol.	Water.	Blue vitriol.	Water.	Blue vitriol.
June 5	10	5	0	0	2	0
6	57	41	20	7	40	20
7	81	63	75	41	77	60
8	91	85	91	72	87	75
9	95	87	93	85	89	79
10	95	89	93	87	91	88
11	95	92	93	91	93	93

Here a general retarding effect of the blue vitriol is visible, even when the application was made for the shortest time. The exceptions which appear are not sufficient to disturb the general result. There was also an enfeebling effect upon the young plants. On June 8 there were in the lot from seed which were soaked in water for ten minutes 6 feeble plants, and in that treated with vitriol for the same time, 23; in the lot treated with water five hours, 12; in that with vitriol, 19; in the lot treated with water twenty-four hours, 4; in that with vitriol, 22; making a total from 300 seeds soaked in water of 22 feeble plants, and from the same number soaked in blue vitriol, of 64.

The next table shows the results of the same solution upon wheat, the dates and conditions being the same as above.

III.—*Blue vitriol upon wheat.*

Date.	Ten minutes.		Five hours.		Twenty-four hours.	
	Water.	Blue vitriol.	Water.	Blue vitriol.	Water.	Blue vitriol.
June 5	77	46	60	23	45	2
6	81	55	77	40	82	10
7	81	58	78	42	86	16
8	82	62	82	43	91	23
9	83	74	85	45	92	29
10	83	79	85	45	92	34
11	85	80	85	48	93	37

It will be noticed from the above table that the wheat germinated much more quickly than the corn, and that the injurious effect of the blue vitriol was somewhat greater.

A more severe test was made with the same solution of blue vitriol (5 pounds to 10 gallons) upon the same sample of wheat by allowing about a pint of the seed to remain in the solution for thirty-nine hours, and the same amount in water for an equal length of time. At the end of that time the water was turned off, a part of the seeds of each lot kept damp by blotting paper, and the remainder planted. Nearly all the seeds which had been in water grew well, but none of those which had been in the solution of blue vitriol.

The next trial was of a solution of copperas or green vitriol upon corn. Copperas is used as a fertilizer, as a fungicide, and as an insecticide. Griffeth in his treatise on manures (London, 1889) after treating extensively of its use as a fertilizer, mentions its value as a fungicide, and states (page 302) that all fungous diseases of wheat may be destroyed by a top dressing of 50 pounds of copperas per acre, or by soaking the seed in a 1 per cent. solution.

In Bulletin 5 of the Iowa experiment station, on page 164, reference is made to the use of copperas as a remedy for cut-worms, the amount recommended being a little over 1 pound for a bushel of seed, with water sufficient to cover the grain.

This strength was taken for the trial, comparison being made with a much stronger solution, and also with pure water. The trial was made in duplicate, one set in the green-house, the other in the open ground, the other conditions being the same. The seed was soaked in each case twenty-four hours, and planted May 17, 100 kernels in a place as in the other tests. The examination was made daily, and, as in the other cases, as nearly as practicable at the same hour, usually at 6 a. m. The record begins on the day upon which the first plants appeared above ground.

IV.—*Copperas upon corn.*

Date.	(*a*) In the green-house.			(*b*) In the open ground.		
	Water.	Copperas, 1 pound per bushel.	Copperas very strong.	Water.	Copperas, 1 pound per bushel.	Copperas very strong.
May 24	51	35	16	12	1	1
May 25	84	70	45	45	32	20
May 26	91	79	68	68	65	59
May 27	94	86	72	80	76	73
May 28	94	87	80	82	80	74
May 29	94	88	85	83	81	79
May 30	94	93	86	84	86	79

A comparison of Tables IV with Tables I and II is sufficient to show that green vitriol (copperas) has nearly as injurious an effect upon the seed as blue vitriol. There was no scorching of the leaves noticeable, however, resulting from treatment with copperas, even with the strongest solution.

TREATMENT OF BLACK-ROT, BROWN-ROT, DOWNY MILDEW, POWDERY MILDEW, AND ANTHRACNOSE OF THE GRAPE; PEAR SCAB AND LEAF-BLIGHT, AND APPLE POWDERY MILDEW.

By B. T. Galloway.

BLACK-ROT.*

The experiments of the past two years have demonstrated beyond question the possibility of cheaply and effectively preventing this disease. Many things, however, in connection with its treatment remain to be discovered, so that rules now laid down will probably have to be modified, as future work gives us a better insight into the nature of the disease and the effects of different fungicides upon it. In the light of our present knowledge we would suggest the following lines of treatment, from which we will leave our readers to make their own selec-

** Læstadia Bidwellii,* (Sacc.) V. R.

tions, since there is little choice, so far as the actual value of the remedies are concerned.

I. After pruning, collect and burn all the trimmings, also as many of the old berries and leaves as possible; the object of this is to destroy the fungous spores which are known to pass the winter in these parts. This accomplished, watch the vines carefully, and as the leaves begin to unfold apply the Bordeaux mixture, formula *b*, taking care to have it reach all parts of the vine above ground. About the time the flowers are opening make a second application of the same formula, this time giving particular attention to the green parts. A third spraying should be made twelve or fifteen days later, a fourth after the lapse of a similar period, and so on until the berries begin to color. A line of treatment, such as the foregoing, will necessitate six or seven sprayings, and the total cost of the same will probably range from $5.50 to $7 per acre, or practically 1 cent per vine.

II. Treat the vines exactly as in I, excepting the first application, which may be omitted entirely, the first spraying being the one made when the flowers are opening. It is not out of place to say here that in no case should the first spraying be postponed later than the last-mentioned period. This treatment will, of course, cost less than I, but whether it will pay to omit the first spraying is one of the questions not yet determined.

III. Treat the same as I, but after the third application abandon the Bordeaux mixture and substitute the ammoniacal solution of copper carbonate. It is very likely that this treatment will prove as effectual as I; at the same time the cost will be less, and the troublesome spotting of the fruit, which always results from the use of the Bordeaux mixture, will be avoided.

IV. Substitute the ammoniacal copper carbonate for the Bordeaux mixture, making the first spraying when the flowers are opening and the others the same as in I. Former experiments have led us to believe that in ordinary seasons this solution will prove as effective as the Bordeaux mixture, and its advantages over the latter are (*a*) ease of preparation and application, (*b*) cheapness, and (*c*) its property of not spotting the fruit.

Those desiring to make further trials should test the effect of spraying the vines in spring, before vegetation starts, with the simple solution of copper sulphate or Bordeaux mixture, formula *a*. It is claimed by some that this early treatment has resulted in much good, but on the other hand there are those who have derived no benefit whatever from it. The question is one to be settled by careful experiments. For further remarks on this subject, see Notes on Fungicides.

BROWN-ROT AND DOWNY MILDEW.*

These diseases, which are caused by the same fungus, occur in nearly all sections where black-rot prevails, and experience has shown that one treatment will answer for all. In the great grape-growing regions

***Peronospora viticola*, DBy.

of northern Ohio and central and eastern New York, where the downy mildew is the principal enemy, the ammoniacal copper carbonate solution will prove an effectual preventive. It should be applied thoroughly to all the green parts of the vine, taking care to make the first application *before any signs of mildew have appeared*—say, soon after the berries are well set. The importance of early treatment can not be too strongly urged. In all cases it must be remembered that these treatments are *preventive*, and being such, it is sheer folly to wait until the enemy appears before beginning the fight.

POWDERY MILDEW.*

It is only in certain parts of the South and along the Pacific coast that this fungus causes any serious damage. In California it has long been the bane of the grape-grower, and this is strange, considering the fact that it is one of the easiest diseases to combat. It succumbs readily to sulphur either in the form of the flowers of sulphur or solutions of the sulphide.

In applying the sulphur, bellows should be used, and the first applications should be made ten or twelve days before the flowers open, the second when in full bloom, and a third three weeks or a month later if the disease seems to be on the increase. The best results are obtained when the applications are made with the thermometer ranging from 80 to 100° F. In this temperature fumes are given off, which quickly destroy the fungus.

We have obtained excellent results in treating this disease with a solution made by dissolving half an ounce of potassium sulphide to the gallon of water. This preparation is cheap and can be quickly and effectually applied with any of the well known spraying pumps. The greatest care should be exercised in making the second spraying, which, by the way, should be at the same time as that mentioned for the flowers of sulphur, in order to protect the blossoms from the fungus.

ANTHRACNOSE.†

This is one of the most difficult of all the grape diseases to combat; in fact we must admit that so far no reliable means of preventing it are known. We can only suggest, therefore, such lines of treatment as have given the best results, hoping that future investigations may throw more light on the subject.

In early spring, before the buds swell, remove, so far as possible, the wood showing the scars made by the fungus, and then treat the vines with a saturated solution (20 per cent. at 20° C.) of iron sulphate. The French apply this by means of mops made of rags, attached to short handles. This is rather slow and awkward work, and we prefer to do it with a spraying machine. As soon as vegetation starts watch the vines carefully, and at the first appearance of the disease apply

* *Uncinula ampelopsidis*, Pk. † *Sphaceloma ampelinum*, DBy.

with a sulphuring bellows a powder made of equal parts of flowers of sulphur and slaked lime. If this does not check the malady, try the sulphur alone.

PEAR SCAB* AND LEAF-BLIGHT.†

Excepting the well known fire blight these diseases are the worst enemies of the pear. They are especially prevalent in New Jersey, Delaware, and adjoining States, frequently causing the loss of entire crops of fruit and thousands of seedlings. The seedlings are especially subject to leaf-blight, but are hardly ever, so far as we know, seriously injured by scab. As the two diseases, however, are usually associated on large trees, and as we have used the Bordeaux mixture successfully on the seedlings, we would suggest that it be adopted for all and applied as follows:

Seedlings.—Make five applications, the first when the leaves are one-quarter grown, others at intervals of ten days until the trees are budded.

Large trees.—Spray five times; first when the fruit is the size of peas, and thereafter at intervals of twelve or fifteen days.

For applying the mixture to trees less than 12 feet high, and especially to seedlings in the nursery, the knapsack pumps provided with the improved Vermorel lance and nozzle will answer.

Where the trees are large and in considerable numbers it will pay to get a strong force-pump, mount it on a barrel, and place the whole in a wagon or cart to be moved about at pleasure. In all cases, however, it will be necessary to use the Vermorel nozzle, as it is the only nozzle of value that will not clog; it can readily be attached to almost any force-pump, and will be found to be a very effective piece of machinery.

The total cost of a course of treatment such as is outlined above, including labor in preparing and applying the remedies, will be for nursery stock about $3 per 1,000 trees. For large bearing trees the cost will run from 6 to 12 cents per tree. In case the Bordeaux mixture shows on the fruit at the time of harvesting it can easily be removed by washing in water.

In addition to the foregoing it would be well to rake the old leaves and fruit together in the fall and burn them, as in this way thousands of the reproductive bodies will be destroyed.

In regions where the scab alone prevails the treatment recommended for apple scab might be tested.

POWDERY MILDEW OF THE APPLE.‡

Powdery mildew is especially destructive to seedlings in the nursery, attacking them soon after the leaves unfold and continuing throughout the growing season, making it impossible to bud them with any degree of success.

* *Fusicladium dendriticum*, Fckl.

† *Entomosporium maculatum*, Lév.

‡ *Podosphæra oxyacanthæ* (DC.), DBy.

When the leaves are about one-third grown begin the treatment by spraying with the ammoniacal solution. In twelve days make a second application of this solution and continue at similar intervals until six or seven sprayings have been made. The applications are best made with the knapsack form of sprayer provided with the Eddy chamber nozzle. The spray of the Vermorel nozzle is too large for this work, but the Eddy chamber can be easily attached to the lance of the former at a cost of 75 cents.

The total cost of such a treatment as outlined abo ve need not exceed 10 cents per 1,000 trees.

WHAT TO DO FOR PEACH YELLOWS.

By Erwin F. Smith.

A series of experiments with fertilizers was begun in 1889, and will be continued until complete and definite results are reached. These experiments are in twelve orchards in different localities and on a variety of soils, embracing a total of about 40 acres, with as many more for comparison. The results last year were not of such a nature as to warrant any affirmative conclusion or any general recommendation.

For the present, at least, I can only indorse the Michigan practice, which is to dig out and destroy every affected tree as soon as it is discovered.

In localities where this method has been practiced with some uniformity they still grow peaches successfully.

In the vicinity of Benton Harbor, Mich., where all the orchards were ruined between the years 1870 and 1880, there are now many fine young orchards, and the yellows has almost disappeared. In the summer of 1889, in company with Mr. Rufus H. Brunson, a former yellows commissioner, I visited many small orchards in different parts of the townships of Benton and St. Joseph, the former chief seat of the disease, and examined nearly 30,000 trees, finding only about fifty cases, nearly one-half of which were in one orchard. More than four-fifths of these trees were less than six years old. Many of the older ones, and most of those which I examined, were in fruit, and the earliest varieties were just coming into market, July 24. With a few exceptions, the only *extensive* orchards were young trees not yet in bearing, the earlier plantings having been numerous, but in a small and tentative way, no single individual caring to risk many thousand trees. Now, however, large orchards are being set. Whether the present immunity will continue is a matter of great interest. If there is any real basis for the belief that the disease may be imported, it certainly will not, for many of the younger trees were procured from infected districts in the East. All fear of the disease seems to have died out, and with it most of the former vigilance.

At South Haven, Mich., where the "rooting out" process was first practiced extensively, and where it is yet in full vigor, they have grown peaches continuously from the start (1852), and there are many old orchards, some of which have stood for twenty-five years. In that locality I examined many representative orchards, and found only a very few cases of yellows. Sometimes, as at St. Joseph, it was a day's work to find a single case. Most orchards of any size do, however, lose some trees each year, their places being filled by trees from the nursery. The South Haven growers, many of whom I have met, no longer fear the disease. They are unanimous in the opinion that the only proper thing is to dig out and burn. This plan they have followed very generally for the past ten years, during which time the disease has not prevailed seriously. Previous to that date many orchards were ruined, the disease having appeared first in 1869.

Until we have a full knowledge of the ætiology of this disease, no better plan can be suggested. Affected trees are always worthless, and the sooner they are converted into stove-wood the sooner new, healthy trees can be grown in their places. *Dig out, then, and burn, and do it promptly.*

TREATMENT OF MILDEWS UPON PLANTS UNDER GLASS.

By S. T. Maynard.

In Bulletin No. 4, Massachusetts Experiment Station, April, 1889, experiments were reported upon the causes and remedies for mildews upon plants under glass. Below we give a brief summary of the results.

ROSE MILDEW.*

Long experience in growing the rose has led many to believe that the rose mildew is brought on by various conditions that weaken the vigor of the leaf, such as want of an abundance of plant food in a proper condition, unhealthy condition of the soil, often resulting from improper drainage, irregular or overwatering, or too sudden changes of temperature, especially after the plants have been forced at a high temperature. The successful rose grower therefore, is one who, by constant care and good judgment, always provides against any or all of the above causes.

REMEDY.

A sure and safe remedy, *with proper precautions*, was found in *evaporated sulphur*. In the use of this remedy a small kerosene stove with a thin iron kettle was used, and the sulphur kept boiling two or three hours thrice each week when the house was closed.

**Sphærotheca pannosa,* (Wallr.) Lév.

Precaution.—The only precaution needed is that the apparatus be placed so that there shall be no danger of its getting upset, and that only heat enough be applied to *boil* the sulphur, for, if by any accident the sulphur should catch on fire, it would destroy all the plants in the house very quickly.

Suggestion.—It has been suggested that if the pipes are painted with linseed-oil and sulphur two or three times each year, similar good results would follow. It has long been the practice to paint greenhouse pipes with a mixture of lime and sulphur, but the results have not always been satisfactory, and the above suggestion may be open to the same objection, although we know of no carefully recorded experiments in the use of linseed-oil and sulphur paint.

LETTUCE MILDEW.*

When grown at a temperature above 40° F. at night, 55° F. in cloudy, and 70° F. in sunny days, lettuce under glass is often rendered unprofitable by the attack of this disease which causes the lower leaves to decay, and often the whole plant to die quickly. Other conditions may in a measure aid in bringing on the disease; for instance, anything that may cause a weak leaf-action of the plant, too much water in the soil, and too much moisture in the house, especially during the night.

REMEDY.

Evaporated sulphur proved beneficial, but not wholly preventive, in fact, only preventive conditions were found satisfactory. These conditions are:

1. A lower temperature at night than during the day, *i. e.*, ranging from 35° F. to 45° F. at night to 50° F. to 70° F. during the day. In sunny weather the temperature may run 10° to 15° higher than on cloudy days.
2. Perfect drainage of the soil.
3. A house naturally dry, light, and airy.
4. An abundance of plant-food in a light porous soil.

Should the plants not start into a vigorous growth soon after transplanting, the application of fine ground bone, one-half pound to a square yard, and 2 ounces of nitrate of soda to the same space, will give remarkable results.

Suggestion.—While it is possible by close and constant attention to provide conditions for the successful growth of both the rose and lettuce under glass, such care and attention adds very materially to the cost of the products, and some means should be devised to destroy the germs

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**Peronospora gangliformis*, Berk.

of these diseases. This may possibly be found in fungicides used in the houses, before the plants are started or by their application to the soil and growing crops while in a young state.

AMHERST AGRICULTURAL COLLEGE, AMHERST, MASS.

TREATMENT OF CRANBERRY SCALD AND CRANBERRY GALL-FUNGUS.

BY BYRON D. HALSTED.

It has been determined by a thorough canvass that a large fraction of the cranberry crop is destroyed by the scald, sometimes called "rot." The loss sometimes reaches as high as 65 per cent., and in many places it has rendered the growing of cranberries a profitless industry.

A fungus is closely associated with this scald, and in no case has a soft berry been examined microscopically without the same fungus being present. The leaves, vines, and roots also of the plants bearing scalded berries, abound in the same fungus. In general structure, habits, and behavior, the fungus of the cranberry scald is closely related to the one causing the black-rot of the grape. As yet no fungicides have been tested upon the scald, but from its relationship to the black-rot of the grape it is only reasonable to infer that the same treatment might be efficacious. In view of the fact that the cranberry has small smooth thick leaves it is possible that the mixtures employed for the grape could be used with greater strength upon the former. However, a beginning can be made with the ammoniacal copper carbonate solution, directions for the preparation of which will be found elsewhere in this JOURNAL. The amount of this solution to be applied per acre can not be stated because it will vary with the rankness of the vines. Apply for the first time as soon as the spring flooding is past, and again just before the blossoms unfold. The third application should be in midsummer, followed by two others at intervals of two weeks. This makes five sprayings in all. The instruments to be used will depend much upon circumstances. If the owner applies Paris green or London purple for the insect enemies of the cranberry, namely, the tip worm, vine worm, etc., then the remedy for the scald can be applied with the same pump.

There is much to be done in improving the *sanitary* conditions, if that term may be used, of the bogs. It is important to have perfect control of the water supply, and during the growing season, while keeping the bog moist enough for the plants, have the ditches deep and free-flowing that stagnant water can be kept from the roots of the plants. Doubtless much depends upon having the soil of the bog in the best condition for the healthy growth of the plants. Where the peat is sour and soaked with standing water the best conditions obtain for the scald. It may be that proper drainage, water control, and

sanding will bring the necessary conditions for healthy plants, and the old plants may outgrow the trouble with the aid, in the meantime, of the remedy proposed. The best thing to do will be to try and see, upon a small area, provided the practical pecuniary test of possible profit prompts the owner. Some bogs are so poorly adapted for this peculiar industry that it will not pay to spend money upon them, others, nevertheless, merit much more attention than they receive.

THE GALL-FUNGUS.

This appears to be confined to a single bog in New Jersey, but in that one it is disastrous. Several closely related shore plants as azalea, sheep laurel, lambkill, white alder, leather leaf, huckleberry, and tea berry or winter green, are attacked by the same fungus (*Synchytrium Vaccinii*, Thomas). The disease is spread by the water in the spring floods and does not pass readily through the air. There is some danger, however, of the pest spreading to other bogs and therefore if this bog was destroyed by fire, together with the infested shore plants there might be hope for a speedy end to the trouble. The matter is so local that it does not merit further treatment here.

The two diseases of the cranberry herein briefly treated are considered at length, with several engravings, in Bulletin 64 of the New Jersey Experiment Station.

RUTGERS COLLEGE, NEW BRUNSWICK, N. J.

TREATMENT OF APPLE SCAB.

BY E. S. GOFF.

Recent experiments indicate that apple scab (*Fusicladium dendriticum*, Fckl.) may be almost entirely prevented by the application of certain liquid preparations, in the form of a spray, that, while harmless to the foliage and fruit of the tree, are destructive to the fungus which causes the disease. Various substances have been found to be more or less beneficial, but at the present state of our knowledge, a solution of copper carbonate in ammonia largely diluted with water is to be most strongly recommended. Experiments conducted, the past season, in the orchard of Mr. A. L. Hatch, of Ithaca, Wis., with this preparation proved so far satisfactory that Mr. Hatch has decided to apply the treatment to his entire orchard of about 25 acres the coming season, as a means of increasing the income from his apple trees.

DIRECTIONS FOR PREPARING AND APPLYING THIS FUNGICIDE.

The copper carbonate and the ammonia may be procured through almost any retail druggist. As the former is not always kept in stock it would be well to order it some days before it is desired for use. The

copper carbonate should be of the "precipitated" form, and is worth at retail about 65 cents per pound. The ammonia should be of a strength of 22° Baumé, and should be procured in a glass or earthen vessel and kept tightly corked, preferably with a rubber cork.

Four ounces of the copper carbonate and 1 gallon of ammonia will be sufficient to give about fifty large or seventy-five medium-sized trees one thorough spraying. As four or five treatments will be needed for a thorough application of the remedy the amount of the materials required for any given orchard may be readily computed.

The best formula that can be given in the present state of our knowledge is to dissolve one ounce of the copper carbonate in one quart of ammonia, and dilute this, when ready to commence the application, with 25 gallons of water.

WHEN TO MAKE THE APPLICATIONS.

In the experiments made the past season in Mr. Hatch's orchard the first application was made after the petals of the flowers had fallen, and when the young apples were slightly larger than peas. But it is the opinion of Mr. Hatch and myself that one spraying before the flowers had opened would have proved beneficial. I would recommend, therefore, one treatment just before the flowers open, a second after the petals have entirely fallen, and others at intervals of two or three weeks until midsummer, or after, if the latter part of summer should be wet.

APPARATUS FOR SPRAYING.

For applying the liquid to the trees, a force-pump, to which is attached a few feet of hose, fitted at the end with a spraying nozzle, will be needed. Excellent pumps are now made by the larger manufacturers expressly for spraying purposes, fitted with all necessary attachments, and costing $10 and upwards. Smaller pumps, which would answer fairly well for a few trees, may be had at from $2 to $10 each.

The same pump which is used for treating the trees for the apple scab may of course be used for applying poisons for the codling moth and other insects. Unfortunately it will not be prudent to add the copper carbonate solution to the same water that is used in applying Paris green or London purple, as the ammonia renders the arsenic more or less soluble and thus the latter would be liable to injure the foliage. But if applied a few hours in advance of the water containing the arsenites, no harm can result from this source.

SUGGESTIONS FOR FURTHER EXPERIMENTS.

The time at which the applications should commence, the number that should be made, and the amount of copper carbonate to be used to accomplish the greatest benefit at the least cost, remain to be settled by experiment.

The most practical remedy for the apple scab must be one that may be applied in the same water with Paris green or London purple without thereby endangering the foliage. It is the opinion of our station chemist, Dr. Babcock, that not only the ammoniacal copper carbonate, but the sodium hyposulphite and the sulphides of lime and potash, all tend to render the arsenic of Paris green and London purple soluble, and hence can not be wisely used in connection with these poisons. The copper carbonate, however, which in the ammoniacal solution is the beneficial agent in preventing the apple scab, does not have this effect when used without the ammonia. The question therefore arises, is the ammonia solvent necessary?

I have recently made some tests with a sample of commercial precipitated copper carbonate, and find that its state of division is such that it remains suspended in water rather better than Paris green, and so may be applied by any apparatus that successfully distributes the latter. It apparently adheres to the foliage nearly or quite as well, when applied in simple suspension, as in the diluted ammoniacal solution.

I recommend, therefore, that those who spray their apple trees for the prevention of injury from the codling moth, make the experiment in a portion of the orchard of adding the precipitated copper carbonate to the water, at the rate of an ounce to twenty-five gallons. No harm to the foliage can result from this measure, while we have every reason to expect that much benefit will accrue in the prevention of the apple scab.

University of Wisconsin, Madison, Wis.

THE COPPER SALTS AS FUNGICIDES.

By F. D. Chester.

In order to make an intelligent comparison between the several well known fungicides containing copper, it is important to understand what salts of copper occur in each and in what relative proportions. This in turn involves some inquiry into the chemical reactions which take place in their preparation and during their stay upon the vine.

For much valuable assistance in the preparation of these notes I am indebted to Prof. C. L. Penny, the Chemist of this Station.

THE BORDEAUX MIXTURE.

Formula.—Copper sulphate, 6 pounds; lime, 6 pounds; water, 22 gallons. In the addition of milk of lime to a solution of copper sulphate, the lime in solution precipitates the copper as cupric hydroxide, forming at the same time a slightly soluuble sulphate of lime. These two salts, together with an excess of lime, remain in suspension in the Bordeaux mixture.

The reaction is simple:

$$CuSO_4, 5H_2O + CaO,H_2O = Cu\ (OH)_2 + CaSO_4 + 5H_2O.$$

From this formula a simple calculation shows that to precipitate the 6 pounds of copper sulphate, there would be required 1.34 pounds of lime (CaO), which would in turn produce 2.34 pounds of cupric hydroxide.

The weight of lime to be used should be considerably increased above this amount, owing to its impure character as ordinarily purchased, but it is likely that 3 or 4 pounds of commercial lime will suffice to satisfy this reaction.

The 22 gallons of water is capable of dissolving approximately .235 pounds of lime, an amount sufficient to precipitate practically 1 pound of the copper sulphate. But since this quantity of lime is immediately thrown down as a nearly insoluble sulphate, the water is free to dissolve another portion of lime, which in turn precipitates another portion of the copper, until all of the copper is thrown down. It is found that this complete precipitation of the copper takes place quickly, or by the time the matter in suspension has fully settled, leaving a clear supernatant liquid, which does not react for copper; hence a long standing of the Bordeaux mixture before use is hardly necessary.

In drying upon the plant the cupric hydroxide in the Bordeaux mixture undergoes no change, hence it is probably this salt of copper which is the active principle.

EAU CELESTE.

Formula.—Copper sulphate, 1 pound; strong ammonia, $1\frac{1}{2}$ pints; water, 22 gallons.

In the addition of ammonia water to a solution of normal copper sulphate, the copper is precipitated as a basic sulphate, forming at the same time ammonic sulphate, which remains in solution. With an excess of ammonia, the basic copper sulphate dissolves to a blue fluid forming the ammonio-copper sulphate ($CuSO_4$, $4NH_3$, H_2O).

In drying upon the plant the ammonio-copper sulphate gradually loses its ammonia and is reconverted into the basic copper sulphate. The following are the probable reactions:

(1) $$\underbrace{3CuSO_4, 5H_2O}_{\text{Normal copper sulphate}} + 4NH_4HO = \underbrace{CuSO_4\ 2Cu(OH)_2}_{\text{Basic copper sulphate.}} + 2(NH_4)_2\ SO_4 + 15H_2O$$

(2) $$CuSO_4, 2Cu(OH)_2 + 2(NH_4)_2SO_4 + \underbrace{8NH_4HO}_{\text{In excess.}} = \underbrace{3(CuSO_4, 4NH_3, H_2O)}_{\text{Ammonium copper sulphate.}} + 9H_2O$$

(3) In drying upon the vine.
$$3(CuSO_4, 4NH_3, H_2O) + H_2O = CuSO_4, 2Cu(OH)_2 + 2(NH_4)_2SO_4 + 8NH_3$$

To satisfy the reactions (1) and (2), the one pound of copper sulphate would require .439 pounds of ammonia gas (NH_3); or 1.66 pints of the

stronger water of ammonia of the U. S. Pharmacopœia (sp. gr. 0.900 at 15^{0} C.), producing in turn .47 pounds of the basic copper sulphate.

MODIFIED EAU CELESTE.

Formula.—Sulphate of copper, 2 pounds; carbonate of soda, $2\frac{1}{2}$ pounds; strong ammonia, $1\frac{1}{2}$ pints; water, 22 gallons. In the addition of a solution of sodic carbonate to a solution of copper carbonate the copper is precipitated as a basic carbonate, forming at the same time a soluble sulphate of soda.

Upon the addition of ammonia the basic carbonate dissolves to a blue fluid forming the ammonio-copper carbonate ($CuCO_3$, $2NH_3$), and the ammonio-cupric hydroxide. ($3Cu(OH)_2$, $4NH_3$, $3H_2O$.)

In drying upon the plant both of these salts gradually lose their ammonia, and are converted into the basic carbonate and into the cupric hydroxide.

The following are the probable reactions:

(1) $$12(CuSO_4,\ 5H^2O) + 12(Na_2CO_3,\ 10H_2O) = 6\underbrace{[CuCO_3,\ Cu(OH)_2,\ H_2O]}_{\text{Basic carbonate of copper.}} +$$

$$12Na_2SO_4 + 6CO_2 + 168H_2O$$

(2) $$6[CuCO_3,\ CuC(OH)_2] + \underbrace{20NH_4HO}_{\text{To dissolve.}} = \underbrace{6(CuCO_3,\ 2NH_3)}_{\text{Ammonio-copper carbonate.}} +$$

$$\underbrace{2[3Cu(OH)_2,\ 4NH_3,\ 3H_2O]}_{\text{Ammonio-cupric hydroxide.}} + 14H_2O.$$

(3) In drying upon the plant.

$$6(CuCO_3,\ 2NH_3) + 6H_2O = \underbrace{3[CuCO_3,\ Cu(OH)_2]}_{\text{Basic carbonate of copper.}} + 3(NH_4)_2CO_3 + 6NH_3$$

$$2[3Cu(OH)_2,\ 4NH_3,\ 3H_2O] = 6Cu(OH)_2 + 8NH_3 + 6H_2O.$$

From the above formula it is found that to satisfy the reaction, the two pounds of copper sulphate will require 2.3 pounds of crystallized carbonate of soda, which will eventually produce .44 pounds of basic carbonate of copper and .38 pounds of the cupric hydroxide, or a total of .82 pounds of the mixed salts.

AMMONIACAL COPPER CARBONATE.

Formula.—Copper carbonate, 3 ounces; strong ammonia, 1 quart; water, 22 gallons.

In the preparation of this solution, the chemistry is the same as that given under modified eau celeste and the reactions are given in formulæ (2) and (3).

Upon the same basis as before, 3 ounces of copper carbonate will yield 1.5 ounces of basic carbonate and 1.32 ounces of cupric hydroxide, or a total of 2.82 ounces. The difference between the modified eau celeste and the ammoniated copper carbonate consists in the presence of sodium sulphate in the former material, and its absence in the latter. Whether this sodium sulphate will be at all harmful to foliage is a question to be decided by experiment, and the writer would advise that this question be tested. The cost of the copper carbonate in the modified eau celeste is approximately 20 cents per pound, while the cost of the commercial carbonate, is, according to present quotations, 65 cents per pound. Furthermore it is seen from the following table that the cost of the basic salts of copper deposited upon the plant, is, in the modified eau celeste, 29 cents per pound, and in the ammoniacal copper carbonate 94 cents per pound ; a difference worthy of serious consideration.

In the use of both the modified eau celeste and the ammoniacal copper carbonate there is not produced continually a basic carbonate of copper, but a mixture of the basic carbonate, and the hydroxide. Would it not therefore be well to try the pure basic carbonate either by precipitating the copper with sodium carbonate, and applying it in suspension as the hydroxide is applied in the Bordeaux mixture or by dissolving this precipitate in ammonium carbonate? By the former method, using 2 pounds of copper sulphate, and 2½ pounds of sodium carbonate, we would have an extremely cheap and perhaps effective fungicide.

The following table has been constructed that the facts contained in this paper might be presented in a condensed form.

The writer in conclusion would particularly recommend that the relative value of the hydroxide, the basic sulphate, and the basic carbonate be tested by the application of materials containing equal weights of these salts per unit of water.

Name of fungicide.	Form of salts when dry upon the plant.	Weight of foregoing salts per 22 gallons.	Weight of original copper salt to make 1 pound of salt when dry on plant.	*Cost of fungicides per 22 gallons.	Cost of 1 pound of copper salt when dry on plant.
		Pounds.	*Pounds.*	*Cents.*	
Bordeaux mixture	Cupric hydroxide, $Cu(OH)_2$	2.34	2.5	34.25	$0.146
Eau celeste	Basic copper sulphate, $Cu\ SO_4$, $2Cu(OH)_2$.	.47	2.13	21.25	.452
Modified eau celeste	Basic copper carbonate, $Cu\ CO_3$, $Cu(OH)_2$, and Cupric hydroxide, $Cu(OH)_2$.	.82	2.44	24.37	.297
		Ounces.			
Ammoniacal copper carbonate.	Basic copper carbonate, $Cu\ CO_3$, $Cu(OH)_2$, and Cupric hydroxide, $Cu(OH)_2$.	2.82	1.06	16.6	.942

* Wholesale cost of materials from which calculations in the last two columns of the above table were made: Copper sulphate, 5⅜ cents per pound ; sal soda, 1¼ cents per pound; strong ammonia (26°), 7 cents per pound; copper carbonate precipitated from copper sulphate by sal soda, 13.87 cents per pound.

DELAWARE COLLEGE, NEWARK, DEL.

NOTES ON FUNGICIDES AND A NEW SPRAYING PUMP.

By B. T. Galloway.

In connection with the papers found elsewhere in the Journal, it would seem proper to say something in regard to the preparation of fungicides, particularly those recommended for use. The manner of preparing most of these, however, has been so fully described in former publications that we deem it unnecessary to repeat the descriptions here. We will say, in passing, that the circulars—Nos. 5 and 6 of the Section of Vegetable Pathology—containing this information will be forwarded to all those desiring to consult them.

Aside from the old and well established preventives and remedies, there are several new ones which we think it would be well to call attention to in order that they may be more fully tested. The first of these is a solution of copper acetate or verdigris, which was mentioned in Volume 5, Number IV, of the Journal. It is prepared as follows:

Dissolve 3 pounds of powdered verdigris in 6 to 8 gallons of water and after standing for twenty-four hours dilute to 22 gallons. If desired the amount of verdigris may be increased to 4 pounds without injury to the plants.

This preparation being comparatively cheap and easily prepared, it would be well to test it for downy mildew and black-rot of the grape, making the applications as described for Bordeaux mixture and the other well-known preparations.

Another preparation which might be tried for downy mildew is made as follows:

Dissolve 5 pounds of alum in 3 or 4 gallons of boiling water, and then pour this solution into a half barrel or tub containing sufficient cold water to make 15 gallons. In another vessel dissolve 42 pounds of calcium chloride in 3 gallons of cold water. Finally, pour the calcium chloride solution slowly into the alum preparation, stirring constantly to effect a thorough mixing.

When the two solutions are mixed there is formed aluminium chloride, potassium sulphate, and calcium sulphate. It is claimed that the fungicidal property lies in the first, while the calcium sulphate facilitates its adhesiveness. The potassium sulphate is, as every one knows, a fertilizer and as it is washed from the leaves it enriches the soil.

In addition to what is said here the papers of Professor Goff and Professor Chester should be carefully consulted, as they contain several new and important suggestions in regard to the preparation and application of fungicides. For the benefit of those having in mind the treatment of plant diseases the coming season, we quote below the usual prices of the various chemicals used in the preparation of fungicides. The quotations are for 100-pound lots. In smaller quantities the prices will range from one-fifth to one-third higher, so that money will be saved

if farmers and fruit-growers will club together in making their purchases. Such an arrangement will also save considerable in the way of transportation expenses.

	Per pound.		Per pound.
Copper carbonate	$0.60	Iron sulphate	$0.02
Copper sulphate	.08	Flowers of sulphur	.04
Potassium sulphide	.25	Alum	.03½
Aqua ammonia (22 Beaumé)	.08	Calcium chloride	.06
Sodium hyposulphite	.03	Aluminium sulphate	.05
Copper acetate	.30	Lime per barrel	2.00

NEW SPRAYING PUMP.

Ever since the work of the Section was inaugurated there has been felt the need of a cheap, serviceable, and effective apparatus for spraying grapes and all the low-growing crops. Heretofore we have had to rely mainly upon machines imported from France; in fact, with but one exception, the only pumps that have given satisfaction in our vineyard work have been purchased abroad. The average fruit-grower can not afford to send to France for a machine that will cost him, laid down in this country, all the way from $18 to $25, nor can he pay $21 for a pump made here, notwithstanding the fact that it is a most excellent machine and costs almost the selling price to manufacture it. In short, a knapsack pump, be it ever so serviceable, at $21 or even $18, is entirely beyond the reach of the average farmer, gardener, and fruit-grower. Consequently he has to rely upon inferior machines, and, as a result, his treatments are frequently unsuccessful for the simple reason that the remedies are not properly applied.

We have had the matter of providing a cheap and serviceable knapsack pump under consideration for some time, and can now positively announce that the machine will be on the market in a few weeks. The pumps will be made in two or three styles, and as there will be no patent on them we hope manufacturers throughout the country will be able to offer them at about $12, thus placing them within the reach of all.

PREVENTION OF SMUT IN OATS AND OTHER CEREALS.

By W. A. Kellerman and W. T. Swingle.

The smuts of oats and other plants are minute vegetable parasites. They appropriate for their use the nourishment which the infected plant prepared for its own development, and in this way reduce its vitality or completely destroy the part attacked. The dark-colored powdery mass popularly called the smut is merely the mature fruit of the parasite, and consists of exceedingly minute reproductive bodies

called spores. These, when subjected to proper conditions, germinate by sending out a slender tube upon which small sporidia appear.

The smut arrives at maturity in case of oats when the latter are in bloom, and the spores, blown hither and thither, find their way into the flowers. The husks soon close over the young grain, and the spores which may have been thereby imprisoned remain dormant until the seed is planted in spring. The warmth and moisture cause the spores and the oats to germinate simultaneously. The slender tubes emitted by the spores now penetrate the delicate oat plants. Thereafter the smut plant grows concealed within its host until they both approach maturity. At this time the smut spores rapidly develop in the abortive head of oats and the black mass of smut becomes conspicuous.

It is sometimes claimed that smut in the soil, or in manure applied to the soil, will infect the young oat plants. This is certainly not the usual mode of infection and it may be doubted whether it ever occurs.

If the spores inclosed in the husks of the grain can be killed without injuring the seed, the smut can be perfectly prevented in the crop. This has usually been accomplished by soaking the seed in a solution of blue vitriol (copper sulphate). This process though destroying all or nearly all the smut, also injures the seed more or less. The hot-water method of Professor Jensen has proven thoroughly effectual in preventing smut and, besides, is not in the least injurious to the seed. In fact, both our own and Jensen's experiments show yields greater than would be expected from the mere prevention of the smut. We therefore recommend this treatment, which consists simply in immersing the infected seed in scalding water (132° Fahr.) for not less than five nor more than fifteen minutes, and immediately thereafter cooling it quickly by immersing in cold water.

In order to carry out this process satisfactorily when a large amount of seed is to be treated, two large vessels must be provided. These can be large kettles hung over a fire, or large boilers on a cook-stove. One vessel is to contain heated water (about 110° to 120° Fahr.) for the purpose of warming the seed preparatory to dipping into the second vessel. This second vessel is to contain water at a temperature of 132° to 135° F. Were not the seed warmed before dipping into the vessel of scalding water the temperature of the latter would be very much reduced, perhaps below 130°, and then the treatment would not be effectual. The seed, a half a bushel or more at a time, is to be placed in a coarsely-woven basket having a lining of wire netting with meshes fine enough to prevent the egress of the grains, say, twelve to the inch. A heavy wire bushel-basket may be used, or a light iron frame made over which the wire netting may be stretched. A lid or cover must be provided for, otherwise a portion of the seed will escape upon immersion. A sack made of coarsely woven cloth might be used instead of the basket, but it is much less convenient. It is necessary that the basket admit the water freely and immediately upon its immersion,

otherwise the treatment can not be expected to be effectual. An immersion of a few moments (less than a minute) will sufficiently warm the basket of seed, provided that it be lifted out then plunged in a time or two and shaken or revolved so that the water may come in contact with the grains. Then plunge it immediately into the second vessel, and with similar motion bring every grain into immediate contact with the scalding water. The lifting and plunging should be continued at short intervals until the seed is removed. In this way every portion of the seed will be subjected to the action of the scalding water. Immediately after its removal dash cold water over it or plunge it into a vessel of cold water and then spread out to dry. Another portion can be treated similarly, and so on till all of the seed has been disinfected.

The important precaution to be taken is as follows: *Maintain* the proper temperature of the water (132° Fahr.), in no case allowing it to rise higher than 135° or to fall below 130°. This will not be difficult to do if a reliable thermometer is used and hot or cold water be dipped into the vessel as the falling or rising temperature demands. Immersion fifteen minutes will not then injure the seed, though no doubt in a less time it will be thoroughly disinfected.

The seed can be treated any length of time before sowing. If it is to be stored it would be necessary to have it first thoroughly dried. If treated immediately before using it can be sowed broadcast when dried sufficiently to prevent adhesion of the grains, but for planting with the drill it would need perhaps to be more nearly dry.

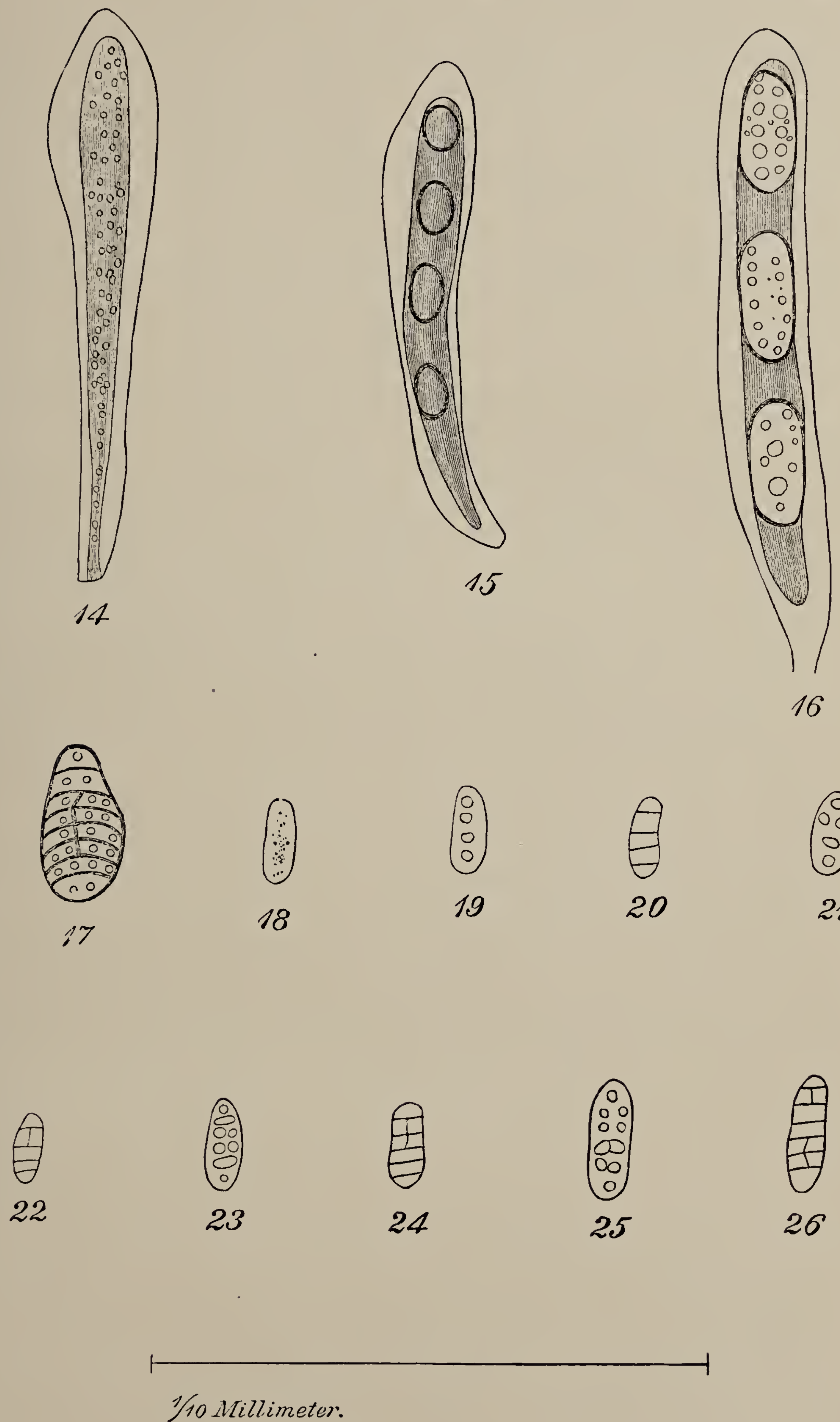
The above outline of treatment is for oats, wheat, and rye. Professor Jensen has determined that barley must be previously soaked in cold water eight hours, otherwise the smut is not prevented.

It is to be remembered that this treatment if universal in any section of country will, besides preventing smut in the crop of the season, also insure clean seed for use the following year. It has been established by actual count that the smut often destroys a very large percentage of the crop. When the smut was reported to be inconsiderable or even absent, we have determined that there may be 5 to 15 per cent. of the heads smutted. These are at harvest time usually overlooked because the smut has been blown away and the inconspicuous naked and clean stalk only remains. It might be added in this connection that it has been established recently that the smuts of barley and wheat, though much resembling that of oats, are really different species.

Finally we may mention by way of suggestion for the benefit of others that farther experimentation is now being prosecuted, or about to be undertaken, having in view the determination of numerous points in connection with the application of fungicides for the prevention of smut. Among these are the following: A comparison of the efficacy under varying conditions of the hot-water treatment with other fungicides; comparison as to increase of yield when this or any other fungicides are used; trial of the Jensen method with other plants besides oats and

C. E. FAIRMAN, DEL.

FAIRMAN ON DEVELOPMENT OF SPORIDIA.



C. E. Fairman, del.

Fairman on Development of Sporidia.

wheat, as barley, rye, grasses, millet, and maize; and the determination of the most favorable form of treatment, particularly with reference to the degree of temperature required, the duration of the immersion in hot water, and the mode of cooling.

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OBSERVATIONS ON THE DEVELOPMENT OF SOME FENESTRATE SPORIDIA.

(Plates I & II.)

BY CHARLES E. FAIRMAN.

The following notes have been made on the development of the sporidia in *Fenestella amorpha*, E. & E.,* and in *Patellaria fenestrata*, C. & P.,† A few comparisons have been made with the spore development of *Camarosporium subfenestratum*, B. & C.

In *Fenestella amorpha* we find the first stage of sporidial development to be represented by the formation of a finely granular protoplasmic layer, in the interior of the ascus. Numerous spherical drops may also be seen a little later in this condensed protoplasmic layer. This layer was not seen to impinge upon the walls of the ascus at any point.

A light-colored homogeneous fluid occupied the space between this layer and the walls of the ascus. Also it was noted that the granular layer did not touch the walls of the ascus at the top or apex. At first this layer appears quite homogeneous. We have designated it the *Sporidiogenic layer* (Fig. 1, plate I).

The sporidiogenic layer is generally broader at the apex of the ascus and narrows somewhat towards the base. In *Patellaria fenestrata* the same general characteristics of this layer will be found to exist. In this species the sporidiogenic layer is at times continuous with the base of the ascus, a condition of affairs which was not made out in the case of *Fenestella* (Fig. 14, plate II).

The next feature observed in the development was the formation of larger spherical bodies in the interior of the sporidiogenic layer. These spherical bodies are the first indications of the forming sporidia (Figs. 2, 3, and 4, Plate I, and Figs. 15 and 16, Plate II). In *Fenestella amorpha* the number generally found was 8, and in *Patellaria fenestrata* 4 (although more may be occasionally seen in the latter). As mentioned above, the general outline is spherical, and they seem to be placed at nearly equal distances apart, in number corresponding to the sporidia commonly found in the ascus of the species under consideration. They are the forming or immature sporidia. Nuclei next make

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*Journ. Mycol., Vol. IV, p. 58. †28th Report N. Y. State Mus., p. 68.

their appearance in the primitive sporidia (Fig. 2, Plate I, and Fig. 15, Plate II).

In *Fenestella amorpha*, with the appearance of the nuclei in the immature sporidia, the sporidiogenic layer begins to lose its distinctness of outline and to be either absorbed or resolved.

In *Patellaria fenestrata* the sporidiogenic layer persists longer. (See Fig. 16, Plate II.) Our observations will not warrant a definite answer to the question how long it does remain. It has been suggested that it persists to the full development of the sporidia and forms a mucous coating to the sporidia (of *Patellaria*). Peck, in 28th Rep. N. Y. State Museum, page 68, says of this species: "Asci subclavate, spores four to eight *involved in mucus*, large pyriform," and gives later as one of the points of distinction between this species and *Patellaria dispersa*, Ger., that "the spores are longer in proportion to their breadth and involved in mucus." The nuclei increase in number, but this increase is variable in different species and probably in the same species. The number of separate divisions in the matured sporidia corresponds closely with the number of nuclei formed during the process of segmentation of the sporidia.

In *Fenestella amorpha* from 5 to 7 nuclei form inside the sporidia, in *Patellaria fenestrata* 7 or more, in *Camarosporium subfenestratum* spores from 4 to 7. (Fig. 19, Plate II.)

The nuclei now enlarge and fill up the sporidia. Some of them subdivide into two or more. In *Fenestella amorpha* the majority subdivide. In *Camarosporium subfenestratum*, as far as observed, the nuclei do not all subdivide. Generally a few near the middle of the spore subdivide.

Up to the commencement of this stage the sporidia of *Fenestella amorpha* are hyaline or subhyaline; but with the subdivision of the contents of the sporidia we find a decided darkening in color. In *Patellaria fenestrata*, and in *Camarosporium subfenestratum* also, the same change of color becomes noticeable. As the development of the sporidia progresses the color gradually darkens.

With the increase in size of the divisions of the sporidia and the changes in the secreted cell walls we now have in *Fenestella amorpha* very dark-colored sporidia, whose *transverse septa* correspond to the limits of the first formed nuclei, and the *longitudinal septa* to one or more of the subdivisions of the same.

In *Fenestella amorpha* the longitudinal septum is irregular; where the subdivisions number three the longitudinal septum runs between them, so that we have one on one side and two on the other, and where the subdivisions are four, two will be found on each side of the septum.

To recapitulate.

The development of fenestrate sporidia may be divided into three stages, viz:

First. The formation of the sporidiogenic layer.

Second. The segmentation of the immature sporidium.

Third. The maturation.

EXPLANATION OF PLATES.

PLATE I.

FIGS. 1 to 13. Development of sporidia of *Fenestella amorpha.*
1. Formation of sporidiogenic layer.
2, 3, and 4. Primitive sporidia.
5–12. Stages in sporidial development.
13. Mature ascus and sporidia.

PLATE II.

FIGS. 14–17. Sporidial development of *Patellaria fenestrata.*
14. Formation of sporidiogenic layer.
15–16. Formation of primitive sporidia.
17. A nearly developed sporidium.
18–26 represent stages in development of spores of *Camarosporium subfenestratum.*

The scale applies to both plates.

NEW SPECIES OF FUNGI.

BY J. B. ELLIS AND B. T. GALLOWAY.

ÆCIDIUM CREPIDICOLUM, *n. s.* On leaves of *Crepis acuminata*, Helena, Mont., June, 1889. Rev. F. D. Kelsey, No. 98. Amphigenous, small, clustered but not crowded, often subcircinate around a vacant space in the center, hemispheric and closed at first, soon open, peridium thin, white, margin narrowly reflexed, at length lacerate cleft nearly or quite to the base. Spores subglobose, 20–24μ, varying to ovate and elliptical, 20–30 by 15–20μ (smooth?) with a rather thick epispore. The leaf is slightly thickened in the affected spots. Clusters 2–3 milimeters in diameter, few on a leaf, or smaller (3–6 æcidia together) and then more numerous. Differs from *Æcidium crepidis*, Thüm. in having the æcidia mass deeply buried in the leaf. *Æcidium Rostruppii*, Thüm. has the æcidia larger, but possibly our plant may not be distinct from *Æcidium Barkhausiæ*, Roum.

USTILAGO (SOROSPORIUM?) BRUNKII, *n. s.* In sheaths of *Andropogon argenteus*, destroying the inflorescence. College Station, Brazos County, Tex. H. S. Jennings. Inclosed in the sheaths without any distinct membranaceous covering. Spores globose or ovate, 10–18μ, in diameter, often apiculate, olivaceous brown under the microscope, finally subopaque. Epispore smooth, thick (3–4μ). The spores are partially agglutinated and hence are not as loosely pulverulent or dusty as in most species.

SOROSPORIUM ELLISII, Winter, var. PROVINCIALIS, *n. var.* In inflorescence of *Andropogon provincialis*. Saline County, Mo. (Demetrio), and Custer County, Nebr. (Webber). Differs from the original speci-

mens on *Andropogon Virginicus*, described by Dr. Winter in Bull. Torr. Club, X p. 7, and distributed in N. A. F., 1099, in its more regular-shaped spores, with a thicker epispore and its larger spore glomerules subglobose, 35–150 μ, or oblong, 100–200 by 75–80 μ. The cylindrical mass of spores, also with an elongated bundle of fibers (the remains of the enveloping sheath)?, is inclosed in a light-colored membranaceous sack, which protrudes above, while in the typical form this sack is less distinct and is entirely concealed.

SOROSPORIUM EVERHARTII, *n. s.* In florets of *Andropogon Virginicus.* Newfield, N. J., October (N. A. F., 2265 b.). Glomerules compact, opaque, 50–120 μ, in diameter, globose or oblong, composed of 100–300, or more closely-compacted spores, which do not easily separate and vary from subhyaline to brown and from subglobose 8–10 μ in diameter to oblong, 10–12 by 8–10 μ, with a nearly smooth epispore of medium thickness. The tips of the glumes in the affected florets become bleached, and open in a bifid manner, the lobes more or less reflexed, allowing the subcylindrical mass of spores to protrude. This differs from *S. Ellisii*, Winter in its smaller spores, more compact glomerules, and in attacking single florets instead of involving the entire inflorescence.

DIDYMOSPHÆRIA DENUDATA, *n. s.* On bark of dry dead oak limbs from which the epidermis had fallen off. Newfield, N. J., March, 1889. Perithecia scattered, ovate, suberumpent, minute (one-quarter millimeter), with comparatively thick membranaceous walls, the erumpent apex (about one-third part) roughish, black, with a papilliform ostiolum. Asci cylindrical, about 50 by 7 μ, abruptly contracted below into a short stipe-like base. Sporidia 1-seriate, elliptical, 1-septate, brown, 6–7 by 4 μ. This differs from *D. cupula*, E. & E., in its perithecia not collapsing and smaller, and in its smaller sporidia and shorter asci. It is found on the upper exposed side of the limb which is usually more or less bleached.

OPHIONECTRIA EVERHARTII, *n. s.* On old *Diatrype stigma* and on the decaying bark of oak limbs. Newfield, N. J., January, 1889. Gregarious, Perithecia ovate-globose, about one-sixth millimeter in diameter; granular-pruinose, except the rather acutely papilliform ostiolum dull dirty-yellow. Asci oblong-cylindrical, 75–80 by 12–14 μ, with rather indistinct paraphyses. Sporidia crowded-biseriate, fusoid, yellowish-hyaline, nucleate becoming faintly multiseptate, straight while lying in the asci, curved when free, 35–50 μ long and 3–3½ μ thick in the middle, gradually tapering towards each end.

GLŒOSPORIUM PALUDOSUM, *n. s.* On leaves of *Peltandra Virginica.* Virginia, August, 1889. D. G. Fairchild; Wilmington, Del., October, 1889. A. Commons, No. 977. Spots amphigenous, orbicular, or elliptical, ½–1 centimeter in diameter or by confluence larger, dirty brown, subzonate; margin darker and subindefinite. Acervuli minute (65–75 μ), mostly erumpent above. Spores oblong, granular, 18–22 by 6–7 μ.

Cercospora Brunkii, *n. s.* On leaves of geranium (cult.). Brazos County, Tex., November, 1889. Prof. T. L. Brunk. Spots amphigenous, light-brownish or pale brick color, orbicular or oval, $\frac{3}{4}$–$2\frac{1}{4}$ millimeters in diameter, with a narrow, slightly raised, and rather darker border, which is more prominent on the lower side of the leaf. Hyphæ amphigenous, but more abundant below; pale brown, 90–200 by 3–5μ, subgeniculate, 2–5 septate, forming loose spreading tufts of 5–6 (rarely more). Conidia clavate-cylindrical, hyaline, multiseptate (5–20). 50–125μ. long, 3–4μ. thick (at the lower end). Differs from *C. geranii* in its darker hyphæ with more numerous septa, its larger multiseptate conidia and the raised border of the spots.

Dendrodochium subeffusum, *n. s.* N. A. F. 394. On thallus of some foliaceous lichen on trunk of a pear tree. Farmington, N. Y., August, 1889. E. Brown, 134. Sporodochia subeffused, spreading over parts of thallus and apothecia, collected and condensed here and there into compact orange-red subapplanate masses about 1 millimeter in diameter. Basidia subulate, 25–35 by 2–3μ, sparingly branched. Conidia terminal, solitary, subglobose to ovate and elliptical hyaline 1–2 nucleate, 5–8 by $4\frac{1}{2}$–6μ.

Scoriomyces Andersoni. *n. s.* Under a decaying log of *Pinus ponderosa.* Belt Mountains, Montana. Altitude 6,500 feet. September, 1889. F. W. Anderson. Forms a waxy-yellow porous mass, 4–12 centimeters long, 2–4 centimeters thick and 2–4 centimeters wide, with an irregularly lobed outline and uneven, colliculose surface; lying among the decaying wood and humus and resembling somewhat a mass of collapsed honeycomb. It is made up principally of loosely compacted globose spores, 35–55μ in diameter and filled with coarse granular matter. Differs from *S. Cragini*, S. & E., in its more compact growth and larger spores. In *S. Cragini* they are only 18–20μ in diameter.

NEW FUNGI.

By J. B. Ellis and B. D. Halsted.

Phyllosticta molluginis, *n. s.* On *Mollugo verticillata.* New Brunswick, N. J., October, 1889. Perithecia amphigenous, scattered, black, prominent, 80–100μ in diameter. Sporules oblong or elliptical-oblong, hyaline, 8–10 by 3–4μ.

Septoria rudbeckiæ, *n. s.* On leaves of *Rudbeckia laciniata*, northern New Jersey, September, 1889. Halsted. On *R. hirta*, Wilmington, Del., October, 1889. Commons, 1033. Spots conspicuous, of a weather-beaten or wood-colored brown, 2–4 millimeters in diameter, irregular, subangular in outline, with a definite darker border surrounded by a purplish stain. On *R. laciniata*, often one or two smaller white spots are included in the larger brown spots. On both hosts the spots are paler below. Perithecia epiphyllous, prominent, subacute, black, scat-

tered. Sporules filiform nearly straight, multinucleate, 30–60 by $1\frac{1}{2}$–2μ about the same as in *S. helianthi*, E. & K., to which this is closely allied.

Glœosporium cladosporioides, *n. s.* N. A. F., 2438. On living stems and leaves of *Hypericum mutilum.* Metuchen, N. J., July, 1889. Acervuli subcuticular, nearly black, about 35μ in diameter, superumpent, gregarious. Hyphæ fasciculate, continuous, toothed above, hyaline, becoming brown. Spores oblong, hyaline, faintly nucleolate, 10–14 by $3\frac{1}{2}$–$4\frac{1}{2}\mu$. Very injurious to the host plant.

Cylindrosporium iridis, *n. s.* On *Iris versicolor.* Iowa City, Iowa, June, 1887. A. S. Hitchcock. Acervuli very minute and very numerous, subcuticular, blackish, forming continuous series or strips between the nerves of the leaf for several centimeters in length, the exuded spores appearing like a white tomentum on the matrix. Spores acicular, 15–22 by 1μ. Hyphæ short, subhyaline, mostly toothed above, 8–10 by 2μ.

Zygodesmus pyrolæ, *n. s.* On petioles of *Pyrola rotundifolia.* New Brunswick, N. J., July, 1889. Forming a reddish-gray, thelephoroid layer enveloping the lower part of the petiole, which is slightly enlarged and distorted, and finally killed. Hyphæ, reddish-brown, much branched, the branches often issuing at a right angle, divided at their extremities into numerous short, obtuse arms bearing the subglobose, 8–10μ, rather coarsely spinulose-roughened, subhyaline, or reddish-brown conidia. The hyphæ are 3–4μ thick, and show the zygodesmoid joints very distinctly. The general appearance is something like that of *Calyptospora Gœppertiana.*

Cercospora lysimachiæ, *n. s.* N. A. F., 2475. On *Lysimachia stricta.* Jonesburgh, N. J., July, 1889. B. D. H. Spots, none; tufts, effused, covering the lower, less abundantly the upper surface of the leaf, which soon becomes of a dark red and dries up. Hyphæ in dense, spreading tufts, subundulate, subentire, reddish-brown, continuous, 40–50 by 4μ. Conidia, slender, obclavate, multinucleate (becoming septate), rusty-brown, 50–80 by 3μ. Under the hand lens this resembles *C. lythri*, West (specc. in Kunzes F. Sel., 594), but that has longer, slenderer, less densely tufted hyphæ and shorter, broader conidia.

Cercospora cleomis, *n. s.* On *Cleome pungens.* New Brunswick, N. J. Spots amphigenous, suborbicular, gray with a narrow dark border, 2–4 millimeters in diameter. Hyphæ amphigenous, loosely tufted, pale brown, septate, geniculate, 75–110 by $3\frac{1}{2}$–4μ. Conidia slender, hyaline, multiseptate, 75–100 by 3–$3\frac{1}{2}\mu$. Differs from *Cercospora capparidis*, Sacc. in the character of the spots and in its longer conidia and septate hyphæ.

Colletotrichum spinaciæ, *n. s.* On living leaves of spinach, which is much injured by it. Newark, N. J., February, 1890. Maculicolous. Spots round, dirty whitish or greenish, 2–4 millimeters in diameter, with a slightly raised border. Acervuli amphigenous, punctiform, 40–75μ in diameter, clothed with a few (3–12) erect or spreading bristle-like hairs,

60–75 μ long and 4–4½ μ thick at the sub-bulbous base, subhyaline and subacute above, dark brown below, continuous (or faintly septate?). Conidia subfalcate-fusoid, hyaline, 2–4 nucleate, 14–20 by 2½–3 μ, ends subacute, basidia short.

NEW SPECIES OF LOUISIANA FUNGI.

BY J. B. ELLIS AND A. B. LANGLOIS.

OIDIUM OBDUCTUM, *n. s.* On living leaves of young *Quercus* (*falcata?*). St. Martinsville, La., May, 1889. Langlois, 1708. Hypophyllous. Sterile hyphæ, slender (3–4 μ thick), sparingly septate, branched, loosely interwoven and with the large (35–50 by 18–22 μ) barrel-shaped conidia forming a thin continuous or partially interrupted cinereous white layer over the greater part or often over the entire surface of the leaf. The concatenate conidia are formed by the constriction of the fertile hyphæ, rather abruptly contracted at each end and truncate.

OVULARIA MACLURÆ, *n. s.* On living leaves of *Maclura aurantiaca.* St. Martinsville. Hypophyllous on rusty brown round spots, 3–5 millimeters in diameter. Prostrate hyphæ branching, erect (fertile); hyphæ simple or sparingly branched above, slender, 15–22 by 2½–3 μ, continuous, hyaline. Conidia subcatenulate, oval, hyaline, continuous, 6–9 by 2½–3 μ.

DACTYLARIA MUCRONULATA, *n. s.* On decorticated and decaying wood of *Carya.* St. Martinsville, La., May, 1888. Langlois, No. 1220. Prostrate sterile hyphæ obsolete or wanting, fertile hyphæ erect, 35–40 by 3½ μ, continuous or with 1–2 faint septa and brown below, more or less angularly bent, and subhyaline above with terminal and lateral mucronulate teeth bearing the oblong 2-nucleate, hyaline, 8–10 by 2½–3 μ, conidia. The fertile hyphæ appear like a dull-purplish, velvet-like pubescence on the surface of the wood. *D. purpurella*, Sacc., has larger conidia and subspathulate-pointed hyphæ.

CONIOSPORIUM MYCOPHILUM, *n. s.* Parasitic on pileus of *Polyporus pergamenus*, (Fr.) and *Lentinus ursinus*, (Fr.). Louisiana, May, 1888. Langlois, 1306. Forms thin olive-black spots, scattered or confluent about 1 millimeter diameter. Conidia elliptical, olive-black, smooth, about 8 by 4 μ.

HORMODENDRUM DIVARICATUM, *n. s.* On rotten wood. St. Martin's County, La., May, 1888. Langlois, No. 1292. Forming loose, scattered tufts, fertile hyphæ, soon opaque, erect or spreading, 80–150 by 4–5 μ; divaricately branched, the few branches often issuing at right angles, and like the upper portion of the main hyphæ articulated and constricted, separating into subelliptical, or lemon-shaped, opaque conidia, 7–12 by 6–7 μ, the lower ones being the longer, the upper and terminal ones often subglobose.

CERCOSPORA ALTERNANTHERÆ, *n. s.* On leaves of *Alternanthera achyrantha.* St. Martinsville, La. Langlois, No. 1430. Maculicolous. Spots round, 1–2 millimeters in diameter; dirty brown, with a whitish center and shaded brown border; hyphæ, 25–30 by 5μ, continuous, olivaceous, truncate above, arising from a tubercular base about 25μ in diameter; conidia obclavate, hyaline 1–3 septate, 65–80 by 3μ.

CERCOSPORA THALIÆ, *n. s.* N. A. F., 2426. On living and dead leaves of *Thalia dealbata.* St. Martinsville, La., October, 1889. Hyphæ amphigenous, very short, ovate, 6–8 by 5μ, olivaceous, mostly protruding in fascicles of 6–15 from the stomata of the leaf. Conidia cylindrical, olivaceous, 3–8 septate, 50–100 by 6–8μ. Ends rounded and obtuse. The hyphæ form dense, slaty-black, narrow, elongated patches 1½–2 millimeters wide and 3–5 millimeters long between the veinlets of the leaf in the same manner as in *C. zebrina*, Pass.

MACROSPORIUM CAROTÆ, *n. s.* On living leaves of *Daucus carota*, to which it is very injurious. St. Martinsville, La., June, 1888. Langlois, No. 1327. Turning the leaves yellow, then brown black, and killing them entirely. Sterile hyphæ erect, at first simple, straight, brown, and septate, finally somewhat branched above, and 80–100μ high by 4–6μ thick. Conidia clavate, brown, 5–7 septate, with one or two of the upper cells divided longitudinally, 55–70 by 12–14μ, on long, slender (1½–2μ thick), permanent pedicels 80–110μ long.

GRAPHIUM SQUARROSUM, *n. s.* On dead stems of *Sambucus.* St. Martinsville, La., July, 1888. Langlois, 1381. Cinereous gray, stripes ¾–1 millimeter high and about 20μ thick; erect, straight; composed of closely compacted fibers, with their hyaline free ends densely spiculiferous and spreading on all sides nearly at right angles below and obliquely upwards above, 8–12 by 2½–3μ, nearly straight or acutely and sharply bent, with their apices dentate and subobtuse. Conidia borne on the spiculiferous ends of the spreading fibers, ovate-oblong, hyaline, continuous, 5–7 by 2–2½μ. Some of the conidia are larger (10–11μ long) and 2–3 nucleate. It is uncertain whether these belong to the *Graphium* or are accidental.

SPHAERIDIUM LACTEUM, *n. s.* On decaying herbaceous stems. St. Martinsville, La., January, 1888. Milk white, minute (¼–½ millimeter in diameter), contracted at base so as to appear briefly substipitate. Sporophore branched in a dendroid manner above, the branches moniliform, constricted, and separating into elliptical hyaline, 5 by 3μ, conidia.

PHYLLOSTICTA VIRENS, *n. s.* On living leaves of *Quercus virens.* Louisiana, February, 1887. Langlois, No. 1070. Spots amphigenous, 1 centimeter in diameter, pale grayish-brown, subirregular, definitely limited by a slightly darker line. Perithecia partly erumpent, small (75–100μ.) Sporules oblong-elliptical or subovate elliptical or subfusoid, hyaline, 4–7 by 1½–2½μ. Differs from the other species on oak leaves in the character of the spots and size of the sporules.

VERMICULARIA DISCOIDEA, *n. s.* On dead culms of *Panicum proliferum.* Pointe a la Hache, La., February, 1887. Langlois, 1041. Perithecia for some time covered by the epidermis, discoid, ½–1 millimeter in diameter, orbicular or subelliptical, rather thickly and evenly covered with straight continuous black bristles 79–80 by 4–5μ, and subbulbous at base. Sporules falcate with attenuated acute ends, 3–4 nucleate, hyaline, 35–40 by 5μ. This seems to be quite distinct from any described species.

HAPLOSPORELLA TINGENS, *n. s.* On dead culms of *Andropogon muricatus.* St. Martinsville, La., March, 1889. Langlois, 1783. Perithecia subcespitose, 2–3 together or densely crowded, often seriately erumpent, becoming nearly superficial, conical, about one-third millimeter in diameter and one-half millimeter high. Sporules oblong-elliptical, 18–20 by 9–11μ. The culm is tinged slaty-black within.

DIPLODIA BAMBUSÆ, *n. s.* On dead stems of *Bambusa.* Mostly near the nodes. Perithecia hemispheric one-third to one-half millimeter in diameter, papillate. Sporules elliptical, brown, 1–septate and slightly constricted, 15–20 by 8–10μ.

DIPLODIA CUCURBITACEÆ, *n. s.* On dead pumpkin-vines. Pointe a la Hache, La., March, 1887. Langlois, No. 1049. Perithecia innate-erumpent scattered, their apices projecting and covered with the blackened epidermis. Sporules elliptical, brown, 1 septate, 20–25 by 10–12μ.

BOTRYODIPLODIA VARIANS, *n. s.* On dead limbs of *Lagerstrœmia.* St. Martinsville, La., January, 1889. Langlois, 1784. Perithecia erumpent superficial, solitary, oftener connate in clusters of 2–4 or more, conical, rough except the obtusely conic ostiolum, about one-half millimeter in diameter and a little more than that in height. Sporules elliptical, brown mostly continuous, some of them 1–septate, not constricted, 15–22 by 8–11μ. This may be the *Diplodia lagerstrœmiœ*, Speg., but that is said to have "sublenticular" perithecia only 200–250μ in diameter.

HENDERSONIA TINI, *n. s.* On dead spots in living leaves of *Viburnum tinus.* Lafayette, La., December, 1887. Spots large (2–3 centimeters), cinereous with a purplish-red border. Perithecia amphigenous, punctiform, innate-erumpent. Sporules fusoid, nucleolate, nearly straight, pale straw-yellow, 22–27 by 2½μ. Approaches *Septoria.* Probably the stylosporous stage of *Leptosphaeria tini*, E. & E.

PROSTHEMIELLA HYSTERIOIDES, *n. s.* On decorticated wood of *Salix nigra.* Near New Orleans, La., September, 1886. Langlois, 1792. Acervuli scattered, minute, punctiform or hysteriiform, covered above by a spurious perithecium, tinging the wood of a reddish color. Conidia in threes, cylindrical, hyaline, nucleate and imperfectly 5–6-septate, 30–35 by 1½μ, arising from short cylindrical basidia.

REVIEWS OF RECENT LITERATURE.

GIARD, ALFRED. *Sur quelques types remarquables de champignons entomophytes.* Bulletin Scientifique de la France et de la Belgique, 1889; pp. 197–224. Three plates.

This articles comprises a series of notes on a number of species of entomogenous fungi the greater part of which have already been published in a communication to the Société de Biologie, and which are here republished in a fuller form and with the addition of notes.

Of the nine species mentioned eight are species named and described by himself, and four of these represent new genera. Over half of the article is devoted to the three species *Entomophthora saccharina*, Giard, *E. plusiæ*, Giard, and *E. calliphoræ*, Giard, all of which are illustrated. He has made many trials in germinating both the resting spores and conidia of *E. saccharina* and finds that the latter lose their power of germination very rapidly and by September 1 it is impossible to infect insects with them; the resting spores would not germinate either in the insects or any artificial substratum, and moreover, before spring the bodies of the infested insects containing the resting spores had become covered with the sand of the dune on which he found them. He does not attempt to answer the question as to what becomes of the resting spores or how the caterpillars are infected in the spring.

E. plusiæ came to the author's notice in 1888 on some caterpillars of Plusia gamma which were destroying a field of trefle and luzerne. He did not find the resting spores but thinks it possible that they may appear on the autumn generation of the insect, and suggests that it may be the conidial form of *E. megasperma.* Attempts to inoculate any form of Sylpha opaca failed entirely, but the author believes that the inoculation of Plusia is particularly favored by an Acridien which reproduces on the infested insects.

During the researches on *E. calliphoræ* two forms of resting spores were found, recalling both by this fact and a remarkable similarity of spores the *Basidiobolus ranarum* of Eidam. The infested Diptera were discovered to be filled with resting spores and Giard is inclined to think that the following is the history of the fungus. The resting spores are eaten with the Diptera by Batrachians. They germinate in the digestive tube and produce conidia and some resting spores on the excrementa. Here they are eaten by the Calliphora, in the bodies of which they produce resting spores incapable of germination without a change of host. The experiments necessary to demonstrate this hypothesis have not been made.

The other species described or noted are *E. forficulæ* on Forficula auricularia: *E. Fresenii*, Now., which he has transferred from the genus *Triplosporium* and considers as probably identical with *Neozygites aphidis*, Witz., *Chromostylium chrysorrheæ* Giard, *Epichlœa divisa*, Giard, *Halisaria gracilis*, Giard, and *Polyrhizium leptophyei*, Giard.

The article closes with some general observations, among which the following facts of general interest are brought out:

(1) The use of entomogenous fungi in combatting injurious insects can not be of any injury to man except as they may infect useful insects such as the silk-worm.

(2) No reliable means have yet been ascertained by which injurious insects can be combatted by *Entomophthoreæ.* The question is a more difficult one than has been supposed.—E. A. S.

MASSEE, GEORGE. *A Monograph of British Gastromycetes.* Annals of Botany, November, 1889, Vol. IV., No. XIII, pp. 1–103. Four double plates.

This monograph, which may well be used as a hand-book for collectors of British fungi, is also of interest to American students of this group. The work contains a discussion of the group in general and of the families comprising it, which is much more readable than De Bary's description of the same as found in the translation of his Morphology and Biology of Fungi. There are also chapters on Affinities and Distribution. A table is added giving the entire list of genera, distinguishing the British ones and noting the entire number of species and numbers of British species.

Mr. Massee divides the *Gastromycetes* into the following families: *Hymenogastreæ*, *Sclerodermeæ*, *Nidularieæ*, *Podaxineæ*, *Lycoperdeæ*, and *Phalloideæ.* The first corresponds, as regards the genera included, almost exactly to Saccardo's descriptions of the same. He includes the genus *Sphanchnomyces* under *Hymenogaster*, and says that a specimen of *Pompholyx sapidum* found near Chichester is evidently a species of *Scleroderma.* He differs from Saccardo in considering the *Sclerodermeæ* as one of the primary divisions of the *Gastromycetes*, and includes in it the following genera: *Polygaster*, *Scleroderma*, *Polysaccum*, *Arachnion*, *Scoleciocarpus*, *Paurocotylis*, *Ciliciocarpus*, *Lycogalopsis*, *Glishroderma.* These are all included in Saccardo's sub-family *Sclerodermeæ* of the *Lycoperdeæ*, but do not comprise all of the genera that Saccardo assigns to the sub-family; the others are placed in the *Lycoperdeæ.*

Massee says that the *Sclerodermeæ* occupy an intermediate position between the *Hymenogastreæ* and *Lycoperdeæ*, differing from the former in not being subterranean and from the latter in the absence of the capillitium and the indehiscent peridium. The genera included in the *Nidularieæ* are the same as those of Saccardo's Sylloge.

In his table of genera he ranks the *Podaxineæ*, which Saccardo regards as a sub-family of the *Lycoperdeæ*, as a family of equal value with the latter. It contains no British genera, however. His *Lycoperdeæ*, therefore, include considerably fewer genera than Saccardo's family of the same name. He characterises it by the constant presence of a capillitium produced from the hyphæ of the trama or peridium and remaining mixed with the spores after the deliquesence of the tramal and hymenial elements. Winter's family *Tulastomei* is placed as a genus

(*Tulastoma*) under the *Lycoperdeæ.* Much attention is given in this, as in others of Mr. Massee's articles, to synonyms and references to literature, and a complete Bibliography is appended, besides the very full references in the description of species.

The plates are excellent, both from an artistic and a scientific point of view.—E. A. S.

WAGER, HAROLD W. T. *Observations on the Structure of the Nuclei in Peronospora parasitica, and on their behaviour during the formation of the Oospore.* Annals of Botany, November, 1889, pp. 127–146. One double plate.

The fact that even the general occurrence of nuclei in fungi has been and is disputed, and that only two observers have ever made any attempt to investigate the phenomena of karyokinesis, even where the presence of nuclei was unquestioned, renders this paper unusually interesting.

The best results were obtained by imbedding the material in paraffine and cutting ribbon sections with a Cambridge microtome. By means of this process, the details of which are given, nuclei were found and their division watched in every portion of the fungus.

In the hyphæ.—The nuclei are most numerous where the hyphæ appear to be completely full of protoplasm, and in well stained sections the chromatin can be seen to arrange itself into threads, which are arranged in the equatorial plane, and which finally separate into two groups, the divisions moving to the opposite poles of the nucleus. Neither the spindle nor the longitudinal splitting of the chromatic elements were observed.

In the oogonium and antheridium.—Large numbers of nuclei are present in both oogonia and antheridia; in the former they become arranged in a layer in the periplasm, and all, with those of the antheridium, pass simultaneously through the karyokinetic processes; two (or three?) of the nuclei of the oogonium then pass into the center, and a wall is formed, shutting out the periplasmic nuclei which rapidly divide into smaller ones. At the same time an antheridial tube is developed, into which some of the nuclei of the antheridium pass. Of these one probably passes into the oospore; the remainder seem to pass into the periplasm of the oogonium, when the antheridial tube becomes disorganized. The ripe oospore contains several nuclei, and its endo- and exo-spore are formed from the periplasm and nuclei contained in it.

In the gonidia.—The nuclei of the gonidia are larger than those of other portions of the fungus, and differ in structure. There are a large number in each spore, but neither their division nor their origin has been observed.—E. A. S.

WARD, H. MARSHALL. *Timber and Some of its Diseases.* 8mo., 295 pages. Macmillan & Co.

The author, in this little volume, although treating the subject in a somewhat popular way, will especially interest the readers of this

JOURNAL, by his descriptions of the various diseases to which our forest and fruit trees are subject. Of the thirteen chapters, seven are devoted to the descriptions of the modes of growth of specific fungi which have, from their abundance and destructive nature, attracted the attention of tree growers.

Those which receive considerable attention, are the following:

Trametes radiciperda, Htg., the principal cause of "wet rot" or "red rot" of timber; *Agaricus melleus*, Secr.; *Polyporus sulphureus*, Scop.; *P. vaporarius*, Krombh., and *Merulius lacrymans*, (Jacq.) Fr., causing conjointly "dry rot;" *Peziza Willkomii*, Htg., pathogenetically connected with the larch disease or "canker;" *Coleosporium senecionis*, (Fr.) Pers. (*Peridermium pini*) the cause of the "pine blister;" and *Phytophthora omnivora*, DBy., which produced the "damping off" of young seedlings. The author has endeavored in the descriptions of these diseases to put the whole matter in such language that those unacquainted with the terms of cryptogamic botany may understand, and has devoted a large portion of each chapter to the dangers from these parasites and the most reasonable methods of avoiding such.

While chapter IV, on the theories advanced to explain the ascent of water in tall trees, is perhaps too technical to harmonize well with the other chapters, it will be found one of the most interesting because it brings together in comparison for the first time in any English work, all the prominent theories, old and new, in regard to sap ascension in forest trees.

The well-known theory held by Sachs that the sap ascends through the substance of the cell walls by reason of an extraordinary activity inherent in imbibed fluid, the author is willing to abandon for Hartig's and Godlewskii's osmosis pressure theory which takes refuge in the respiration of protoplasm to furnish the lifting force. According to the views of these investigators the sap ascends by means of the tracheids of the alburnum, and is drawn or forced upwards by a periodic change which the adjacent cells of the medullary rays undergo, by reason of which they alternately absorb water from the tracheids below and expel it into those above.

The remarks upon the healing of wounds by occlusion contain many warnings against the habit altogether too common among fruit-growers and foresters, of allowing freshly broken or cut surfaces of growing trees to remain exposed to the dangers so imminent, from the hosts of parasitic fungi which only await such opportunity to gain a foothold in the tree. As might be expected, repeated references to the work of Hartig and other investigators are met with; but, throughout, the book is well worthy attention.—D. G. F.

SWINGLE, W. T. *A List of the Kansas Species of Peronosporaceæ.* Transactions of the Twentieth and Twenty-first Annual Meetings of the Kansas Academy of Science (1887–'88). Vol. XI, p. 63.

This State list, the largest one yet published we believe, containing 32 species of *Peronosporeæ*, a family acknowledged to flourish best in a

moist climate with frequent showers, is remarkable as coming from a place of scanty rain-fall and long summer droughts. The author adopts for his classification that first used by Schrœter and repeated by Berlese and De Toni in Saccardo's Sylloge Fungorum, giving for convenience translations of the descriptions of family, genera, and sub-genera.

Two new species, *Peronospora hedeomæ*, K. & S., *P. cynoglossi*, Burrill, and a new variety of the latter, *P. cynoglossi*, var. *echinospermi*, Swingle, are quite fully described; measurements of 100 conidia and 25 conidiophores being given to establish the authenticity of the variety. Although it is to be regretted that there are no remarks upon the relation of this family to the atmospheric humidity it is interesting to note that the author finds only the following species as passing the winter in seeding plants: *P. arenariæ*, var. *macrospora*, *P. Arthuri*, *P. corydalis*, *P. parasitica*, *P. hedeomæ*, and *P. candida*.

The reference to an examination of every specimen for oospores as well as the carefully prepared synonomy show the work to be of the highest order. One or two changes in the authorities of some of the common species may attract attention but will be found to be well supported by the law of priority, such as *Cystopus amaranti*, (Schw.) Berk and *Peronospora parasitica*, (Pers.) Fries.

The addition of the localities from whence specimens have been obtained together with other convenient helps make the paper a very valuable one to State collectors.—D. G. F.

INDEX TO NORTH AMERICAN MYCOLOGICAL LITERATURE.

By David G. Fairchild.*

1. Dudley, W. R. Notes on investigations now in progress (with figures). Second Annual Report of Cornell Ag. Ex. Sta., 1889. Issued February 15, 1890. I. The onion mold (*Peronospora Schleideniana*, DBy.). II. Anthracnose of currants (*Glœosporium ribis*, (Lib.) Mont. and Desm.). III. Leaf-blight of quince and pear (*Entomosporium maculatum*, Lév.)

*In addition to the reviews of recent foreign articles as published in the past we propose in the future to give an index to the North American Mycological Literature, endeavoring so far as possible to bring the information down to the time each issue of the Journal goes to print. In order to facilitate the work we shall be greatly obliged if the botanists will give us notice of any articles of a mycological nature contributed by them to other than the current scientific publications; and also in giving such information to state the exact date of publication. As Experiment Station bulletins and annual reports are seldom dated exactly, it will be a great convenience if botanists will kindly state in sending their reports to us the time at which they were ready for distribution. The work will be in charge of Mr. David G. Fairchild to whom all publications and communications bearing upon the subject should be addressed.—B. T. G.

2. FARLOW, W. G. Poisonous action of *Clathrus columnatus*, Bosc. Botanical Gazette; Vol. XV, No. 2, p. 45. February, 1890. Issued March 5.

3. GALLOWAY, B. T. Fungous Diseases of Fruits and their Treatment. Colman's Rural World, March 13, 1890, an address to the Peninsula Horticultural Society, second annual meeting, Chestertown, Md.

4. HALSTED, B. D. Some Fungous Diseases of the Cranberry. Bulletin 64 of New Jersey Agricultural College Experiment Station, December 31, 1889. I. The Cranberry Gall Fungus (with figures). Discovery and history. Structure. Inspection of the bog. Related species of plants infested. Comparison of galls on differents hosts. Study of infested bog. Recommendations for combating the gall. A new and as yet undescribed species of the genus *Synchytrium* (*S. vaccinii*, Thomas) is found to be the cause of this peculiarly local and destructive disease and its structure and life history, so far as possible in one year's study, are carefully worked out. II. The Cranberry Scald (with figures). Distribution of the fungus. Description of microscopical characters. The results of the first year's investigation of this obscure and in New Jersey, at least, extremely destructive disease, in which the mycelial threads of a sphæriaceous fungus are traced from the soil of the bog up through the stem and branches to the leaves and fruit where they mature their reproductive bodies. Preliminary suggestions are given as to the possible lines of treatment.

5. Hollyhock Diseases (*Puccinia malvacearum*, Mont., and *Cercospora althæina*, Sacc). Garden and Forest. March 26, 1890, p. 158.

6. KEAN, ALEXANDER LIVINGSTON. The Lily Disease in Bermuda (with plate), Botanical Gazette; Vol. XV, No. 1, p. 8, January, 1890. Issued January 28, 1890. A carefully prepared description of the parasitism of a species of *Botrytis* identical with that described by H. Marshall Ward in Ann. Bot., November, 1888, as it appears in Bermuda upon *Lilium Harrisii.* The author suggests as a possible remedy for this threatening disease the planting of some other crop in alternate rows, which, with high and spreading foliage, will prevent the collection of dew upon the leaves, and thus check the fungus so dependent on moisture for its propagation.

7. SCRIBNER, F. L. Root-rot of the Vine (*Agaricus melleus*, Secr. and *Dematophora necatrix*, R. Hartig). Orchard and Garden, January, 1890, p. 12.

8. Black-spot of the Rose (*Actinonema rosæ*, (Lib.) Fr.). Orchard and Garden, March, 1890, p. 57.

9. SEYMOUR, A. B., and EARLE, F. S. Economic Fungi. Fascicle I. Cambridge, Mass. January 1, 1890. The first of a series of fascicles of fungi parasitic upon cultivated or noxious plants. In book form, $3.50; unbound, $3.

10. THAXTER, ROLAND. I. Smut of onions (*Urocystis cepulæ*, Frost), (with plates). Annual Report of the Connecticut Agricultural Experiment Station for 1889. Report of the Mycologist. Issued March 11. History; origin; general characters; distribution and severity; conditions influencing prevalence and increase; dissemination; retention of germinative power by spores; occurrence or non-occurrence in sets and seed onions; botanical history and relations; manner of infection; experiments for prevention; general precautions. A most admirable treatment of the disease in which the botanical history and origin as well as the practical points of inquiry are well worked out. As the fungus seems to enter the plant only beneath the ground all treatments of seedlings must be before they appear above the surface of the soil. Only powdered fungicides were applied, scattered along the drills and slightly mixed with the soil before the planting of the seed. Although the author is not warranted he believes from his tentative experiments in recommending the use of flowers of sulphur as a preventive of the disease, it appears to him at least a promising substance for that purpose; of much more value than powdered copper sulphate which prevents germination of the seed, or iron sulphate, and less expensive in cost and application than sodium sulphide. The cost with rows one foot apart when the fungicide composed of one part of flowers of sulphur mixed with an equal part of air-slaked lime is scattered evenly in the bottom of the drills and the seed planted almost directly upon it, will not exceed, exclusive of labor of application, 60 cents per acre. II. The onion mildew (*Peronospora Schleideni*, Ung.), *ibid.* III. The onion Macrosporium (*Macrosporium sarcinula*, Berk. var. *parasiticum*, Thüm.), (with figures), *ibid.* IV. The larger onion Macrosporium (*Macrosporium Porri*, Ell.), (with figures), *ibid.* V. The onion Vermicularia (*Vermicularia circinans*, Berk.), (with figures), *ibid.* VI. List of fungi parasitic upon members of the genus *Allium*, *ibid.* VII. Mildew of lima beans (*Phytophthora phaseoli*, Thaxter), (with figures), *ibid.*

11. ——— On some North American species of *Laboulbeniaceæ.* Proceedings of the American Academy of Arts and Sciences, pp. 5–14. March 15, 1890. A preliminary communication on American members of this order, to be supplemented by a more extended account; to form the second part of a proposed monograph of *Entomogenous* plants.

12. WEBBER, H. J. Uredinial Parasites. Am. Nat., Vol. XXIV, No. 277. January, 1890, pp. 75, 76.

13. ——— Peridial Cell Characters in the classification of the Uredineæ. Am. Nat., Vol. XXIV, No. 278. February, 1890, p. 177.

14. ——— Peculiar Uredineæ (with plate). Am. Nat., Vol. XXIV, No. 278. February, 1890, p. 178.

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U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF VEGETABLE PATHOLOGY.

Vol. 6. No. II.

THE JOURNAL OF MYCOLOGY:

DEVOTED ESPECIALLY TO THE STUDY OF FUNGI IN THEIR RELATION TO PLANT DISEASES.

EDITED BY

THE CHIEF AND HIS ASSISTANTS.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1890.

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VOLUME 6, No. 2. } JOURNAL OF MYCOLOGY. { ISSUED September 10, 1890.

EDITED BY

THE CHIEF AND HIS ASSISTANTS.

CHIEF,
B. T. GALLOWAY.

ASSISTANTS,
EFFIE A. SOUTHWORTH. DAVID G. FAIRCHILD. ERWIN F. SMITH.

ANNOUNCEMENT.

By a recent act of Congress the Section of Vegetable Pathology has been made a Division, thereby placing it on an equal footing with the other branches of the Department. In view of the fact that the change in name necessitates the inauguration of a new series of bulletins, it seems a fitting time to modify somewhat the manner of issuing the JOURNAL. In the future, therefore, it is proposed to issue this publication at least four times a year, but instead of having it appear quarterly, as heretofore, we shall endeavor to publish it whenever there is sufficient material on hand to warrant us in so doing. There will be no changes made in the paging of the present volume, which will continue until four numbers, counting the one previous to this, are issued.

A NEW HOLLYHOCK DISEASE.

Plate III.

BY E. A. SOUTHWORTH.

Five or six years ago a very destructive disease made its appearance among seedling hollyhocks in a few large greenhouses in this country; it has since extended to various places in New York and New Jersey, and has nearly put an end to growing hollyhocks for bedding in the Government propagating houses in Washington.

Only a few firms grow hollyhocks in the greenhouse for bedding purposes, but these few are in most cases losing nearly their entire crop; and a reputable florist reports that the disease has quadrupled the price of hollyhocks in New York in the last two years. This malady is entirely distinct from either the well known hollyhock disease of England (*Puccinia malvacearum*, Mont.) which swept through the country a few years ago and destroyed many of the hollyhocks growing in gardens, or from the spot disease caused by *Cercospora althæina*, Sacc., described by Dr. B. D. Halsted in the Garden and Forest, March 26, 1890.

EXTERNAL CHARACTERS.

The fungus may attack any part of the plant: when on the leaf it occurs in the form of a brown spot, which may increase in size until the whole leaf is either diseased or withered; when on the petiole, the leaf and part of the petiole beyond the point of attack shrivel up at once; when at the base of the petiole, on the young unfolding leaves, or on the main stalk of the plant itself, the fungus quickly runs down to the root and kills the plant. Wherever the stem or petioles are attacked they shrivel up; all flow of sap is checked and the part of the plant or leaf beyond this point must succumb. If the plant is very dry, the diseased parts dry up, but if grown in a moist place the trouble is aggravated by swarms of bacteria that attack the diseased portions and, instead of drying up, the plant seems to perish by a kind of wet-rot. When the plant has attained some size and firmness of texture, the surface of the petiole or stem sinks in at the point of attack, forming a distinct flattening or even a hollow. The color of these spots varies from a light-yellowish brown to black. Frequently the centers of the spots are rust-color, becoming entirely black later.

BOTANICAL CHARACTERS.

The disease is due to a fungus closely resembling the well known bean rust [*Colletotrichium Lindemuthianum*, (Sacc. and Magnus) Brios. & Cava.], but the brown setæ or bristles which accompany the spores are much more plentiful than in the bean fungus. No published record of the fungus could be found and I have designated it *Colletotrichium althææ.** In structure the fungus resemles a *Glœosporium* except for the presence of the bristles in the fruit pustules. The spores of *Colletotrichium* in general are either acicular and curved or oblong. This belongs to the latter class.

The basidia and spores are formed beneath the cuticle, which is finally rutured (fig. 5); the setæ appear after the basidia but very early in the history of the fungus. On the older spots they may become so numerous as to make the pustules appear like minute black tufts of hair, and to give the center of the spots on the stems a black color.

The spores, produced by constriction from the stalks or basidia (fig. 2), are unicellular, sometimes becoming once septate at the time of germination. They germinate quickly in nutrient solutions, and by the use of a mixture of hollyhock decoction in agar agar the fungus may be brought

* *Colletotrichium althææ*, n. s.—Epiphyllous and caulicolous, erumpent, forming brown spots on the leaves and light-yellowish brown to black sunken spots on the petiole and stalk. Spores irregularly oblong, frequently with a light spot in the center, granular, colorless singly, flesh-colored in mass, 11–28 by 5μ. Basidia colorless, regularly cylindrical, tapering slightly or rounded at the apex, at least slightly longer than the mature spore, borne on a thin layer of pseudo-parenchyma, simple, but may branch if placed in excess of moisture (fig. 2). Setæ dark brown, abundant, once or twice septate, usually colorless below, 60–109 by 3–5μ, appear later than the basidia.

to perfection in plate cultures. In germination (fig. 4) the spores send out one or two, rarely three, germ tubes, which are continuous at first and filled with granular protoplasm. Sometimes, probably under unfavorable conditions, a secondary spore may form on the end of the germ tube after it has grown for a short distance, and by the time this spore is formed the first spore is empty. The mycelium produced in this way frequently anastomoses, and even the spores occasionally do the same thing, only one of the anastomosing spores sending out a germ tube. In the plant the mycelium is colorless, sparsely septate, and full of vacuoles. It penetrates the cavities of the cells, running through the vessels of the wood as well as the more delicate tissues. The tissues infested by it soon collapse, the cells die, and if the fibrovascular bundles are involved, as they usually are, the ascent of sap is stopped. A few cells on the edge of the spot may usually be observed which are penetrated by the mycelium, but are not collapsed.

The germ tubes developing from the spores sown in culture media may soon become closely septate, or may develop into a mycelium in which septa are only rarely visible, becoming, however, more closely septate as it grows older. The diameter is variable, the larger and older branches being as much as three or four times as broad as the smallest. The older branches are often constricted at the septa and sometimes instead of a constriction at a septum one of the adjacent segments swells up, forming a pear-shaped expansion at the end. The mycelium is colorless at first but in culture media soon grows dark colored and the contents become filled with large oily looking drops. After two or three days it is conspicuous in culture media by its dark color. Where it radiates from a single point the dark color usually extends nearly to the circumference of the spot which is bounded by a light margin composed of the still colorless hyphæ. In about seven days from the time that the spores are sown there are fully developed spore-producing pustules containing setæ on the artificially produced mycelium. Fig. 5 shows one of these very young pustules. The character of spores, basidia, and setæ is essentially the same as on the plant; the basidia may grow a little longer and the setæ are distinctly longer than any seen on the hollyhock itself (cf. figs. 1 and 3). The pustules may develop to a very large size, becoming half as large as a pin-head. They are perfectly black to the naked eye except where the spores form a flesh-colored mass on the top.

These cultures were undertaken with the hope of ascertaining whether the setæ actually belong to the spore-forming fungus. In case of the *Colletotrichium* on the bean this has been questioned because the setæ are frequently present in such small numbers that they are overlooked. This fact led to the idea that they might be parasites, or rather that there were two distinct fungi, one living upon the other.

In cultures I was never able to make one of these setæ germinate, but in one culture there were what seemed to be brown setæ, sending out long branches from their free ends. These could not be called true setæ, however, for they were shorter and broader than the typical ones,

and did not taper towards the ends, neither were they connected with fruiting pustules, but were borne directly on the vegetative mycelium. In fact, they seemed to be short, brown, aerial branches which had grown out into colorless hyphæ. In all the cultures wherever a pustule was produced the setæ were present, and although none of them were made from single spores, there is every reason to believe that they were pure cultures of the spores. No setæ could be discovered among them when carefully examined with the microscope, and they are so large as to be easily visible, moreover the setæ are not easily detached from the mycelium or pseudo-parenchyma at the base of the pustule, and in some cases the spores were merely floated off from the pustule, so that the black setæ could scarcely have been carried with them. Besides, as had been said, a microscopical examination of the cultures revealed only the spores present. The material did not give positive evidence that the setæ and basidia sprang from the same hyphæ, but some of the very young pustules made this almost certain. In case of a similar fungus on cotton, I have seen the setæ bearing spores similar to those borne on the basidia, but nothing of the kind could be seen in this case.

The time of reproduction in artificial cultures agrees exactly with that in nature. Sowing the spores on the leaves of healthy hollyhocks in a drop of water produced well developed pustules in seven days.

Owing to the similarity of this fungus to *C. Lindemuthianum* an attempt was made to produce it on bean pods; this was unsuccessful, but inoculations similarly made with spores of *C. Lindemuthianum* produced the spores of that fungus. The inoculations were made by putting the spores in incisions made with a flamed knife, attempts to produce the bean fungus by sowing the spores on the outside having failed in former experiments.

No trouble was experienced in producing the hollyhock disease on healthy plants. For the first experiment three perfectly healthy seedlings, growing in a shallow pot in one of the Department greenhouses, were selected. There were sixteen plants in the dish and they were so close together that their leaves were in contact. The bases of the plants where the young leaf was not yet unfolded, and the points of union of the blade and petiole of full grown leaves were chosen as points of infection. In a week each of these three plants were diseased at one or more of the inoculated spots, while the other plants in the same dish were perfectly healthy except for a few spots of *Cercospora* on some of the leaves. These spots were entirely distinct from those caused by the *Colletotrichium* spores, and there was no possibility of confounding the two fungi. Later, two of these infected plants were killed by the fungus passing down from the young leaf to the base of the plant. This experiment was repeated by inoculating other plants in the same dish and was successful each time. The fungus which developed on these plants agreed in every particular with the one in Henderson's greenhouses.

GENERAL NOTES.

A number of circulars were sent out to prominent florists asking as to their experience with the disease. Our answers revealed the following facts: (1) Comparatively few florists have ever had any experience with the fungus, but wherever it has made its appearance it has been exceedingly destructive, the losses varying from 25 per cent. to the entire crop. (2) No one who grows hollyhocks entirely out of doors reported the disease, but some of those who reported it on seedlings raised in the greenhouse said it also attacked plants which were raised out of doors and had never been in the house. At Henderson's greenhouses it disappeared at first after the plants were bedded, but last year, owing probably to the wet season, the disease reappeared very violently after the plants were in bud and nearly ready to blossom, killing them root and all. Another correspondent reported that it attacked and killed his plants that were raised entirely out of doors. (3) Putting diseased plants out of doors may check the disease in some cases, but this is very uncertain. (4) Heat and moisture are very bad for the plants; as little as possible of each should be given.

Three dozen perfectly healthy plants growing out of doors in a cold frame were picked out from some Bay Ridge, L. I., nurseries and sent to Washington for experiments with infection. They were not carefully taken up and consequently experiments were delayed until they should recover from the set-back in growth they had received. Half of the plants were potted and put in one of the Department greenhouses while the other half were planted out of doors. Instead of recovering, and before any attempts at infection were made, the plants in the greenhouse were attacked with the fungus and were dead in two weeks. Those out of doors also became diseased, but not so badly and lingered along for some time. These plants had never been in a greenhouse; they were sowed out of doors the fall before, and had lived through the winter in a cold frame. They did not become diseased from contact with other diseased plants, for except the fungus which was produced on the seedlings already mentioned, there was none in the Department grounds, and these plants were kept in another house at some distance from the first. This would look as if the fungus could more readily attack plants whose vitality is in some way decreased, and is a hint to hollyhock growers as to the manner of transplanting.

Raising plants indoors is almost necessary if the demand for bedding plants is to be met in the spring, and consequently those who wish to raise them for the spring trade must either have some remedy for the disease or give up the business. For the purpose of ascertaining whether fungicides which have been of value in other diseases would also answer in this, the following experiment was made in Henderson's greenhouse. Three hundred plants which had been taken out of the greenhouse and put out of doors were brought in and repotted without disturbing the roots. All the diseased leaves were picked off; they were then arranged in three lots of 100 each and placed far enough apart so

that no two plants were in contact. One hundred were left untreated; 100 were sprayed every other day with the ammoniacal copper carbonate solution, and 100 with Bordeaux mixture, 4 pounds of lime to 6 of copper. Only the upper sides of the leaves were sprayed at first, but later the spray was applied to both sides. The results of the experiment were only moderately satisfactory, due in some measure at least to this early exposure of the under sides of the leaves, but in June the plants were visited and the effects of the Bordeaux mixture could be seen for some distance, the lot thus treated being much more vigorous than the other two. The effects of the copper carbonate were not very apparent. There were diseased plants among those treated with Bordeaux mixture, but the foreman of the greenhouses was so encouraged by the results that he had decided to spray the plants out of doors as well.

An experiment made at the Department by Mr. Galloway, on a smaller scale, was less successful. Plants which were dipped in the mixture developed the disease, but there is sufficient encouragement for florists to try the mixture thoroughly another year, taking especial care to spray both sides of the leaves. It is of prime importance to completely clear the greenhouses of all diseased plants and raise an entirely fresh stock. The spraying should begin as soon as the first leaves come out, and be repeated every other day.

For applying the solutions on a small scale, any force-pump will answer, providing it is supplied with a suitable nozzle, such as the Vermorel or Japy. These can now be obtained from nearly all the large firms who deal in florists' supplies. Where the cultivation of the hollyhock is made an extensive business, the knapsack form of sprayer, such as described on page 51 of the present number, will be found very serviceable for applying the remedies.

EXPLANATION OF PLATE.

PLATE III.—*Colletotrichium althææ*, n. s.

FIG. 1. Section through fruiting pustule × 500.

2. Basidia bearing spores at their apices. The branched basidium was drawn from a specimen kept in a moist place × 600.
3. Small fruiting body grown on artificial substratum. It will be seen that the setæ are longer than in fig. 1, which represents the fungus on the plant, × 500.
4. Germinating spores, × 600.
5. Section through young fruiting pustule made before the epidermis had been ruptured × 600.
6. Setæ and spores × 600.
7. Mycelium in the tissue of a leaf as seen through the epidermis × 600.

E. A. S., DEL.

SOUTHWORTH ON HOLLYHOCK DISEASE.

DESCRIPTION OF A NEW KNAPSACK SPRAYER.

By B. T. Galloway.

Since writing the note in the last Journal, relative to a new spraying pump designed by us, all parts of the machine have been perfected, and two firms in this city, Albinson & Company, 2026 Fourteenth street, and Leitch & Sons, 1214 D street, are now manufacturing it.

In view of the fact that any one has the privilege of making and selling this pump we have thought it best to give a detailed description of it, accompanied by illustrations of such a character that any intelligent machinist can use them as working drawings. The demand for the sprayer will be largely confined to the spring and early summer months, and to those who contemplate manufacturing it we will say that it is of the utmost importance to have the pumps in stock at this time. As a rule we find that the men who use machines of this kind wait until the last moment before sending for them, consequently they are anxious to have their orders filled promptly which, so far as our experience goes, is never done. Hence, therefore, the importance of having sufficient machines on hand to fill all orders without delay. Coming now to a description of the machine we have first:

The Reservoir (Figs. I and II).—This is made of 16-ounce copper, and

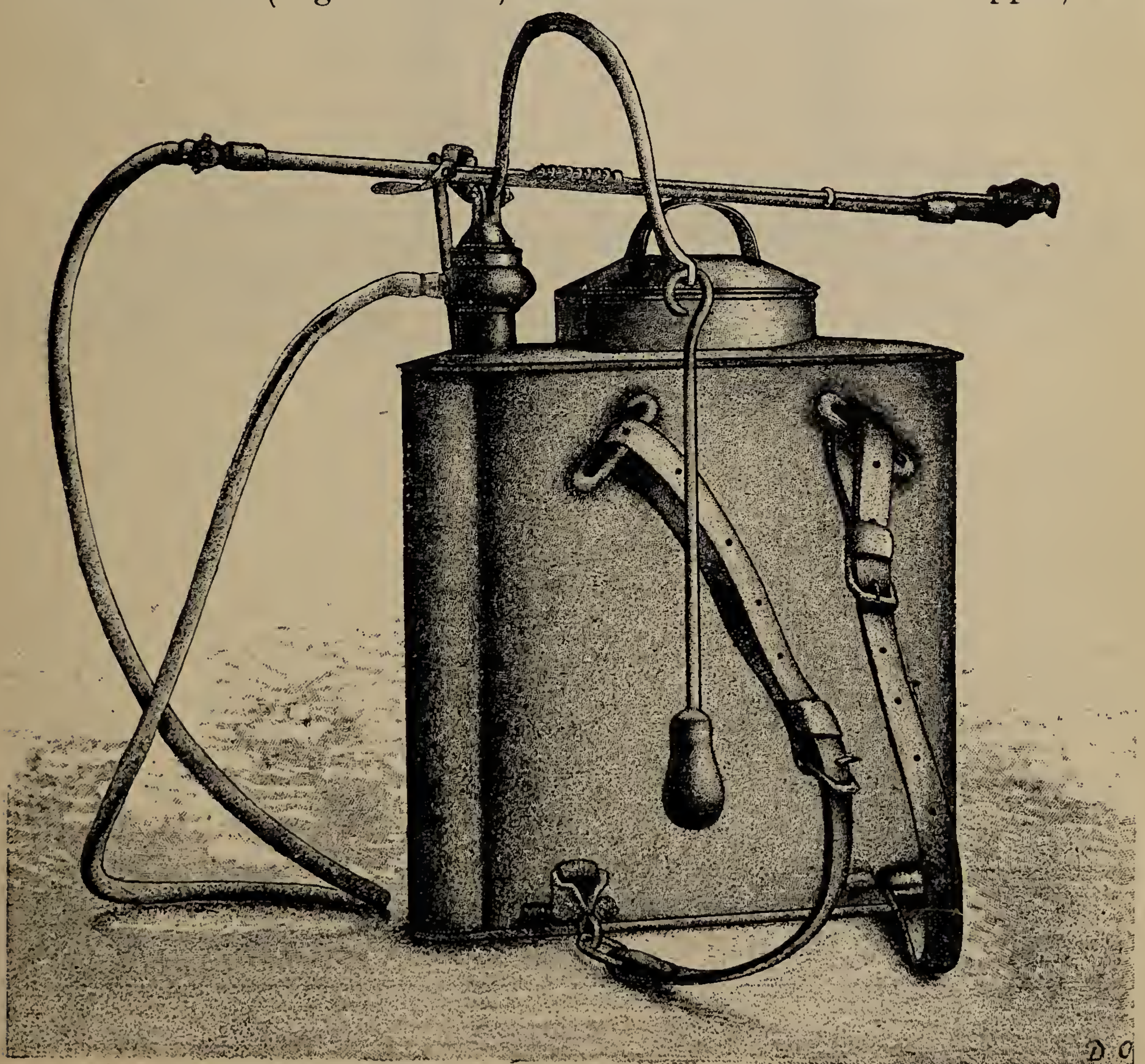

Fig. I.

holds a little over 4 gallons. We first tried 14-ounce copper, and found it too light, on the other hand 20-ounce seemed to be heavier than was necessary, so that we finally adopted the medium grade, which has given perfect satisfaction.

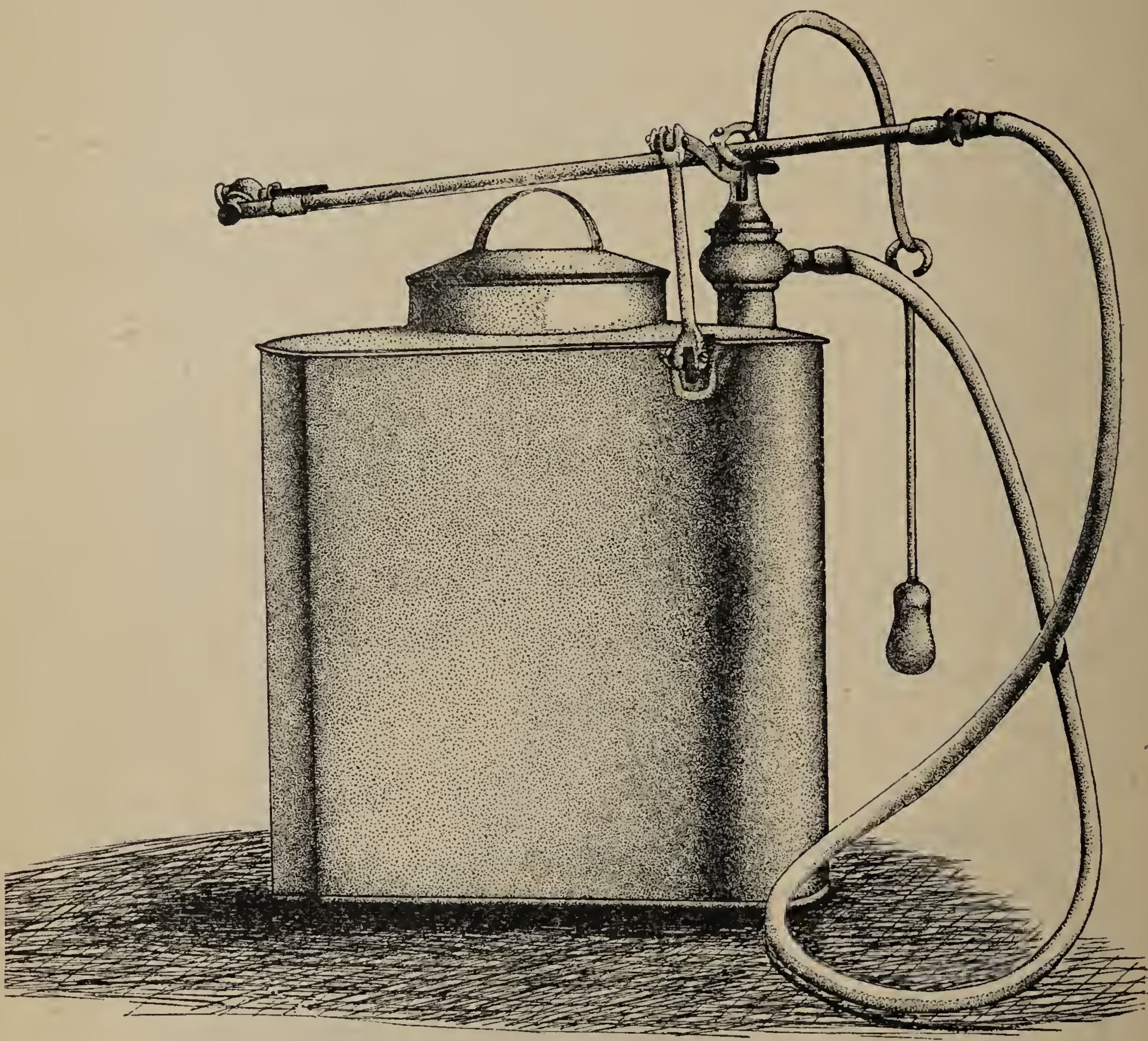

FIG. II.

The height of the reservoir is 16 inches, its breadth 15 inches, and depth 5 inches, 10 pounds of copper being necessary for a tank of these dimensions. When filled with the Bordeaux mixture, or any of the copper solutions now in use, the machine weighs practically 50 pounds, which is about as much as a man wishes to carry on his back for any length of time. In fact we find very few men able to carry such a load constantly for more than a few days at a time. This is why we did not make the reservoir larger, as some advised us to do, thinking one of 6 gallons' capacity about the proper size. Where the pumps are being used three days out of every fifteen, as is the case with many vineyardists, a 6-gallon reservoir would probably not be too heavy, but for a man using the machine six days in the week for three or four months, as must be done in large nurseries, it is simply out of the question.

The bottom of the reservoir as well as the top is soldered in, and, as is shown in Fig. III, the top is provided with two openings, one for the pump and the other for introducing the liquid. The pump orifice, *a*, is 1½ inches in diameter, while the opening for the liquid, *b*, is 4½ inches

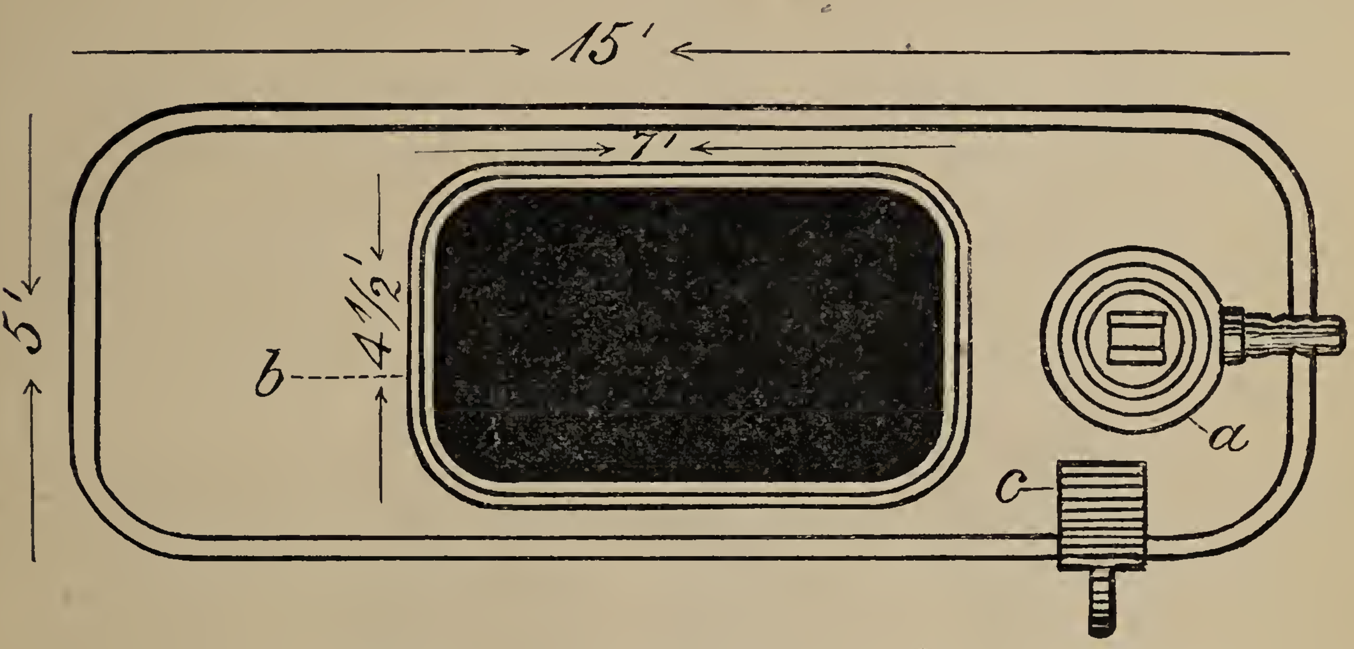

Fig. III.

wide by 7 inches long. Above and surrounding this opening is a rim 1½ inches high, into which is fitted a strainer, made of fine copper wire. The strainer, Fig. IV, rests on a slight projection made in the copper

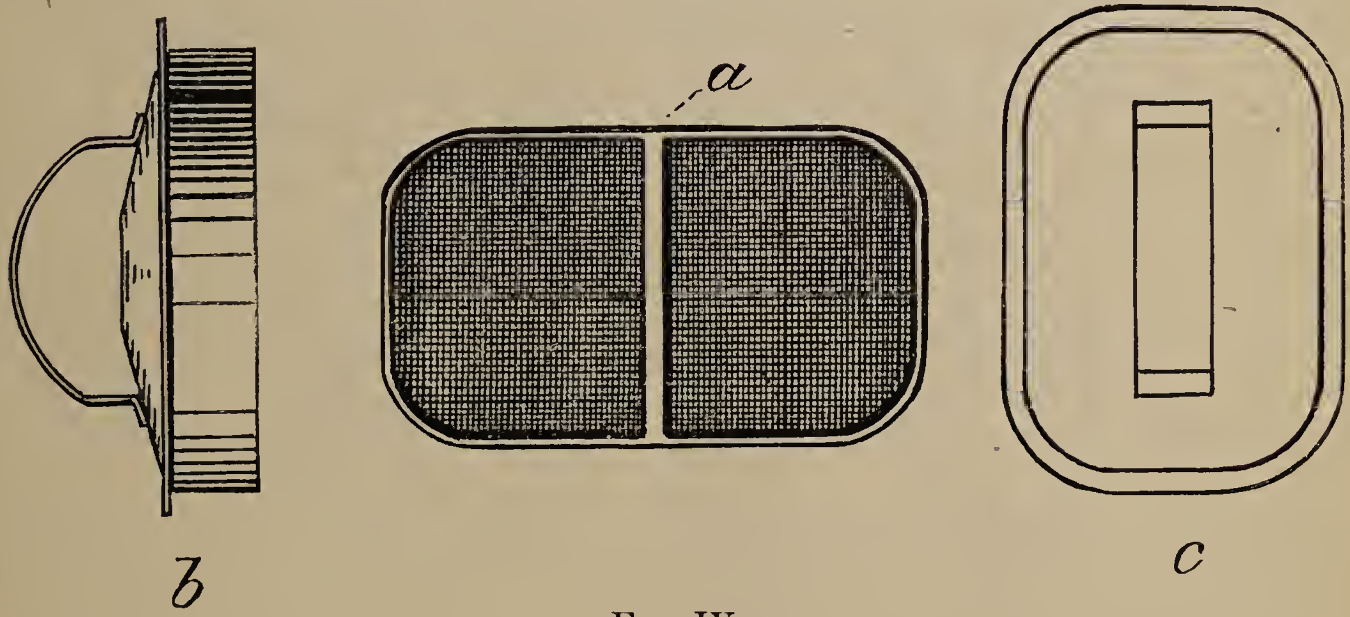

Fig. IV.

at the bottom of the rim, and is removed by means of a handle across the middle, *a*, Fig. IV. For closing the opening a lid made of copper, Fig. IV, *b* and *c*, is used, this fitting down tightly in the rim.

The Pump. (Fig. V.)—The pump is 17½ inches long and 1½ inches in diameter, and for making it 6 castings, weighing 2⅛ pounds, 15½ inches of 1½-inch brass tubing and 14¾ inches of 1-inch brass tubing, are required.

It is not necessary to go into the details of the various parts of the pump, as the figures and explanations thereto will, we think, enable any one to understand the offices of the various parts. The pump is

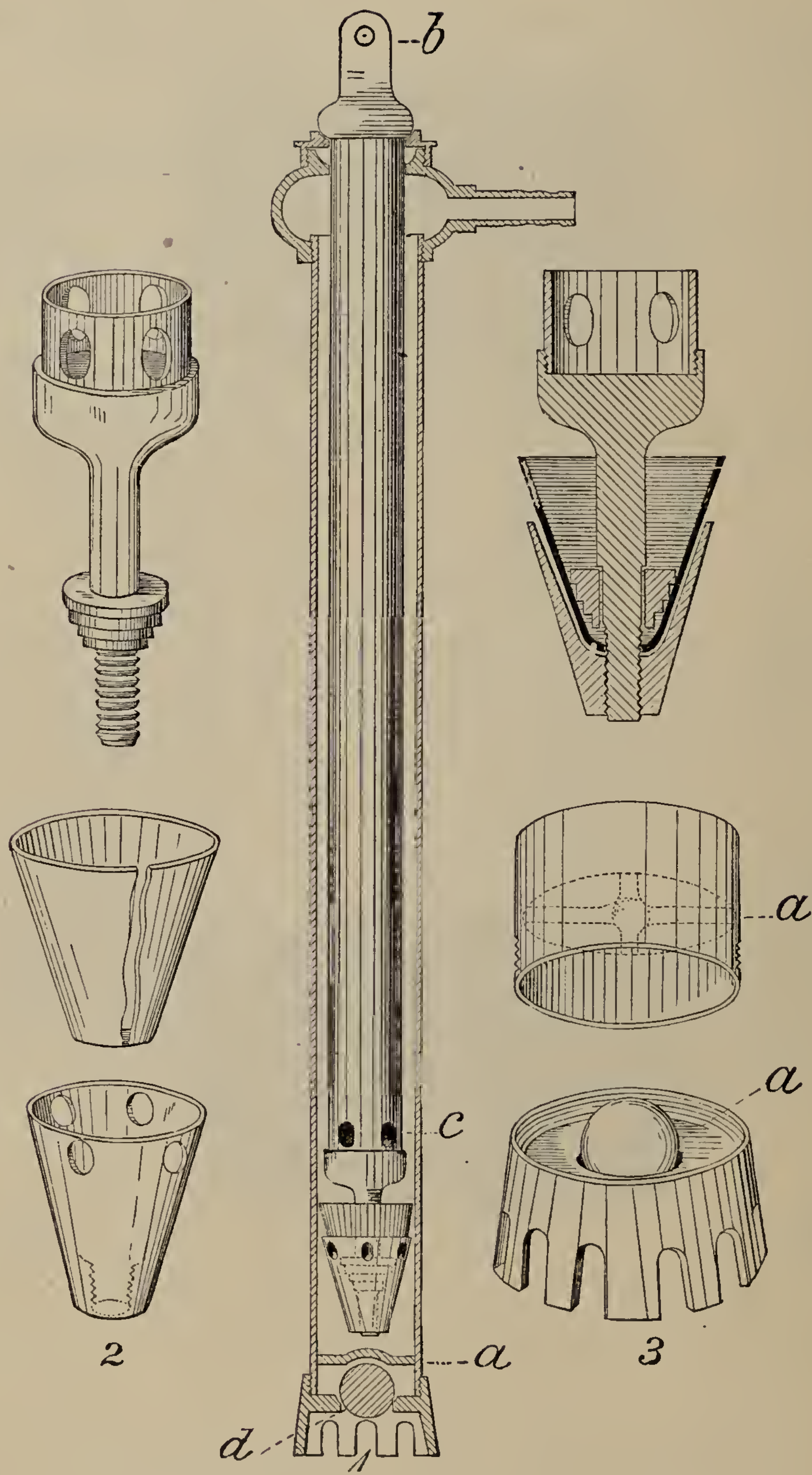

FIG. V.

soldered to the bottom of the tank, the solder being placed at the several points shown at *a* in Fig. VI.

It is fastened at the top, Fig. VI *b*, by means of solder also; for some reasons this is objectionable, but as it will not be necessary to remove the tube it is not a serious inconvenience after all. To obviate the difficulty, however, a nipple might be soldered in the tank at *b*, into which the tube could be screwed. The plunger is made in two styles, but for various reasons we have abandoned that shown in Fig. V, and now use only the form illustrated at VII. This is screwed to the end of the tube, the end being left open to do away with the necessity of side port-holes as shown at *c*, Fig. V. As seen in the cut, the plunger is not packed, the space *bb* being left for this purpose; ordinary wicking is used for packing.

In using the pump the hollow piston is drawn up creating a vacuum into which the liquid rushes through the opening *d*, Fig. V. The piston is then forced down and this closes the valve *d*, Fig. V, and opens the one at *a*, Fig. VII. This operation being repeated the liquid is forced out of the opening in a continuous stream, the latter being effected by means of the air-chamber in the piston. The figures show plainly the various parts necessary for working the pump, attaching the reservoir to the back, etc. We use as a rule about 4 feet of $\frac{7}{8}$-cloth insertion hose, and this is fastened to the pump and lance by means of copper wire.

Lance and Nozzle.—These are practically the same as described by us in a previous number of the JOURNAL,* the only difference being a change in the location of the spring which operates the degorger.

Summing up briefly the cost of such a machine as here described, we have the following:

10 pounds 16-ounce sheet-copper, at 23 cents per pound	$2.30
$2\frac{1}{2}$ pounds castings, at 25 cents per pound	.62
Castings and labor on lance	2.00
Straps and hose	.75
13 hours' labor, at 40 cents an hour	5.20
Total	10.87

* Vol. 5, No. II, p. 96.

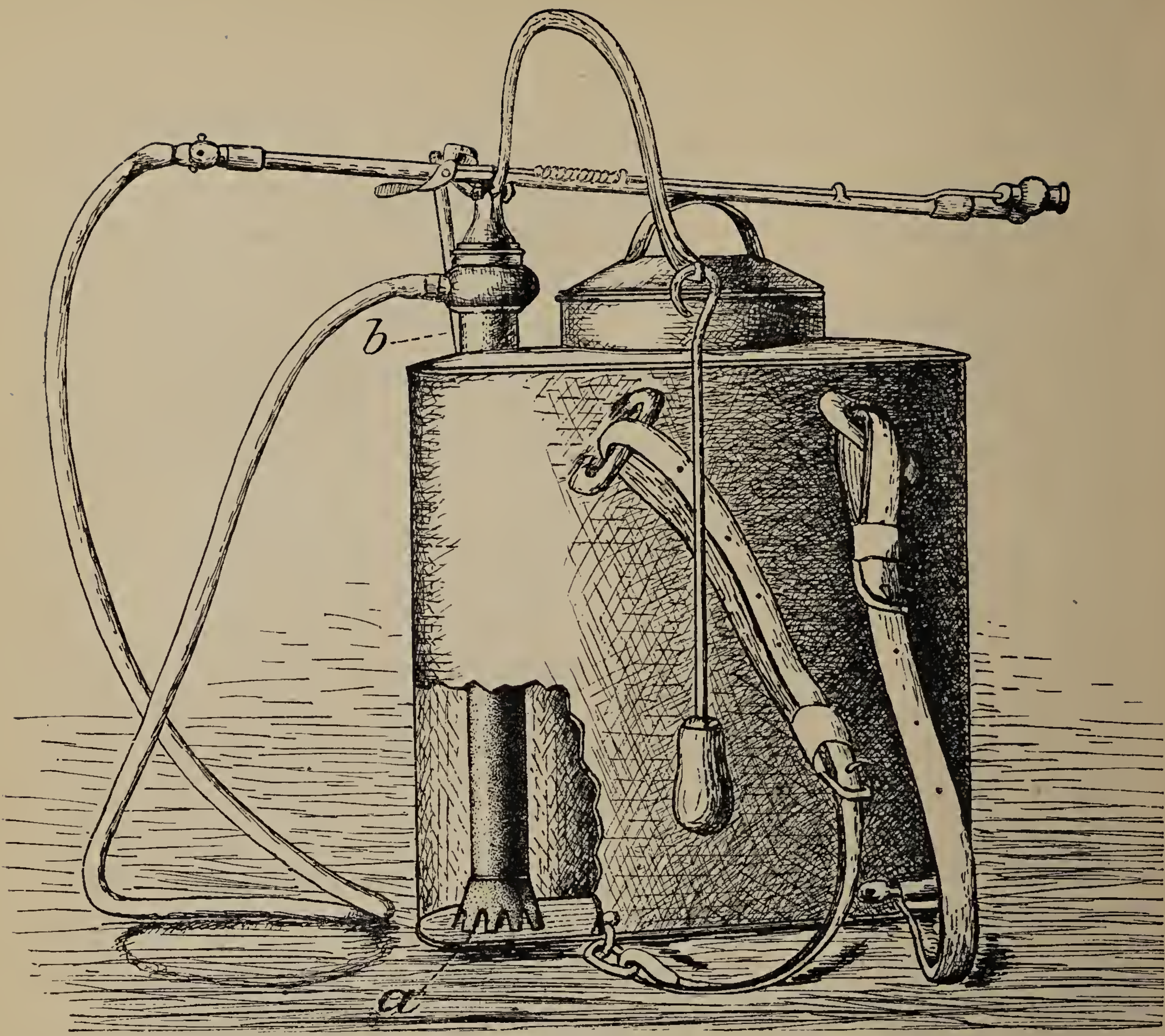

Fig. VI.

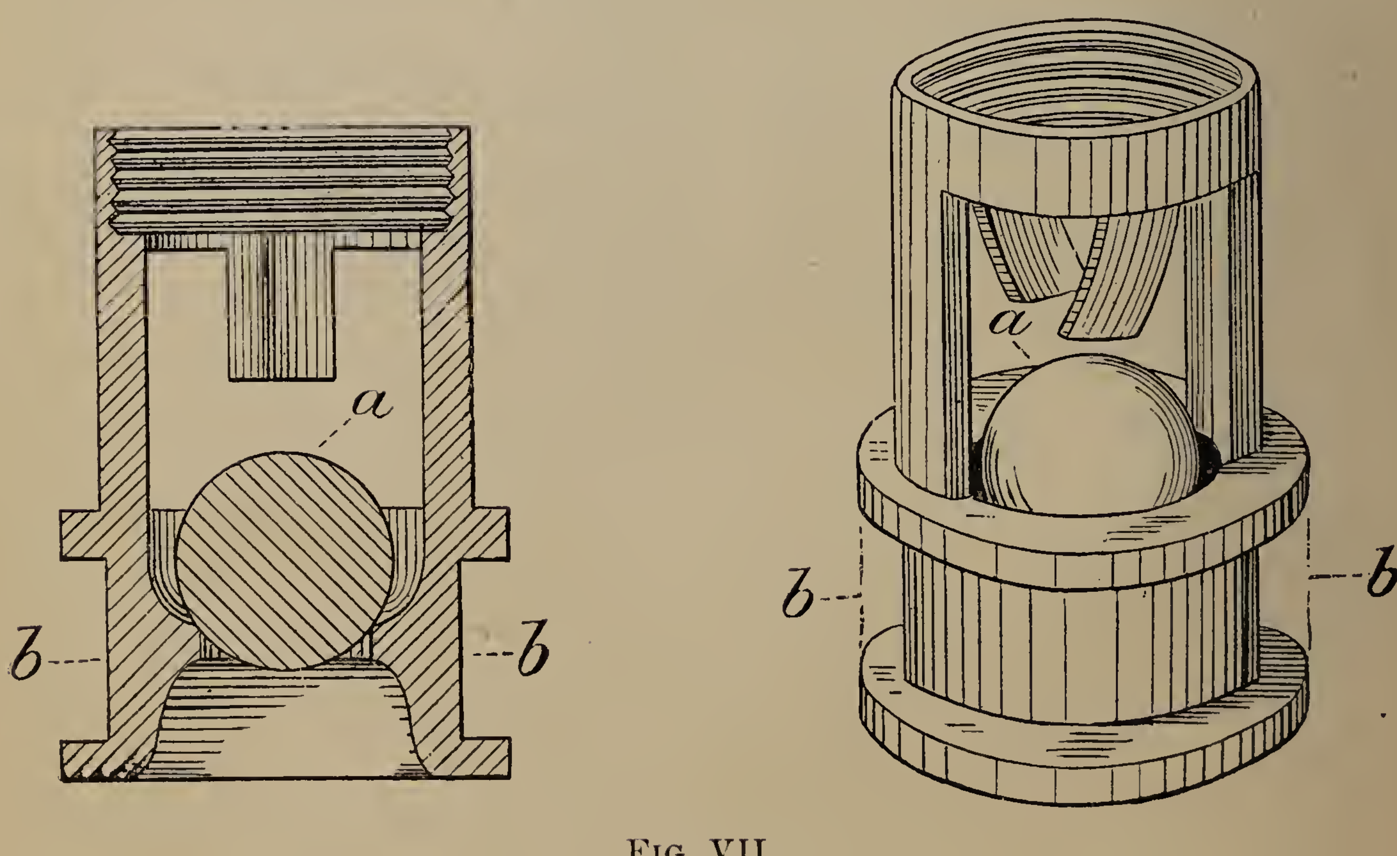

Fig. VII.

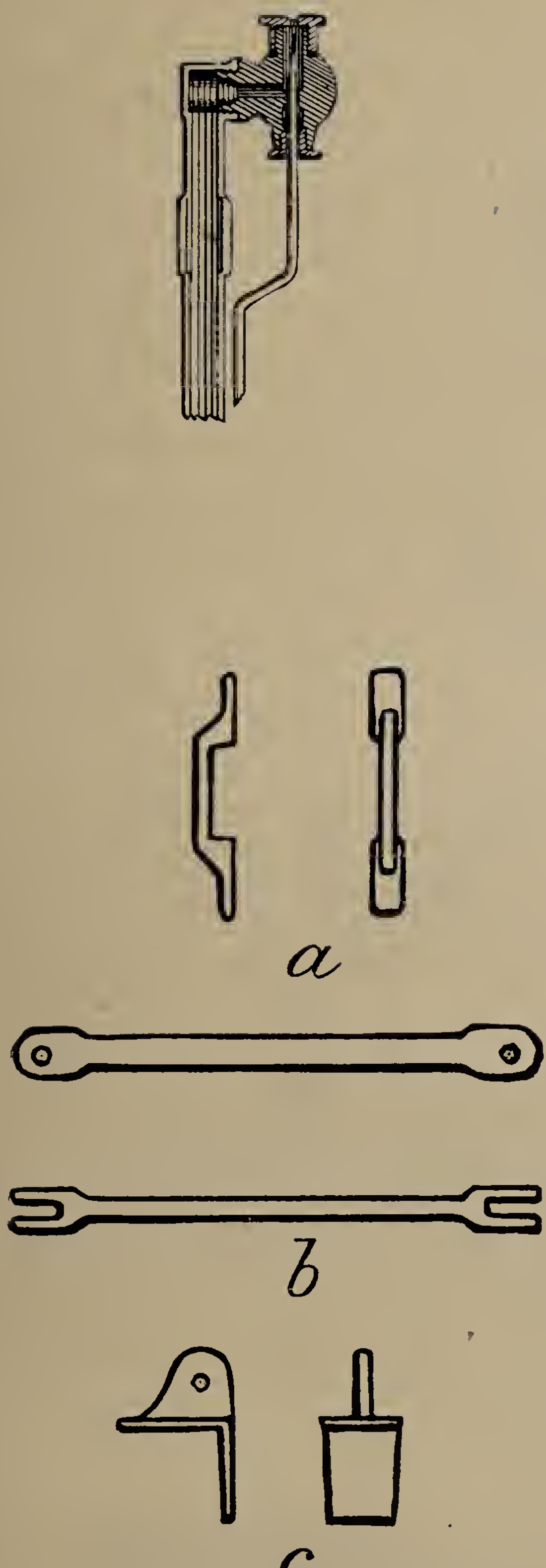

Fig. VIII.

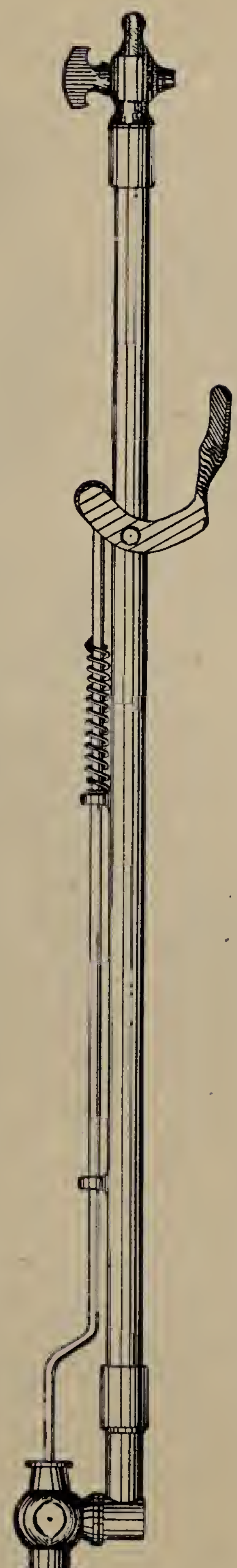

Fig. IX.

Fig. X.

EXPLANATION OF FIGURES.

FIG. I. Front view of reservoir showing straps and attachments, pump, handle, lance, and hose.

II. Back view of reservoir showing pump, handle, lance, hose, and fulcrum; also manner of attaching the latter.

III. Top view of reservoir. Top view of pump, opening 2½ inches in diameter *a*; opening for introduction of liquid, 7 inches long, 4½ inches wide, *b*; casting for holding the fulcrum, *c*; one-fourth actual size.

IV. Strainer, 7 inches long, 4½ inches wide, 1 inch deep; wire gauze soldered on the bottom, and handle *a* across the top; *b* and *c* lid, one-fourth actual size.

V. Pump complete. 1 one-fourth actual size; 2 and 3, one-half actual size. The plunger shown here has been abandoned and the one at Fig. VII substituted. The cross piece made of brass shown at *a* in 1 and 3 is retained in the new form. This piece holds the ball of the valve in place.

VI. Front view of reservoir showing pump inside; soldered at points seen at *a*.

VII. Plunger with ball valve showing ball at *a*, and space for packing at *bb*, actual size. The tube to which this is fastened is 14¾ inches long, making the total length with the piece marked *b*, in Fig. V, 17 inches.

VIII. Casting for attaching straps, *a*; fulcrum, *b*; casting which is soldered to reservoir *c*, as shown in Fig. II, and to which the lower end of the fulcrum is fastened by means of a bolt. All one-fourth actual size.

IX. Lance and nozzle one-fourth actual size.

X. Sprayer in use.

RECENT INVESTIGATIONS OF SMUT FUNGI AND SMUT DISEASES

AN ADDRESS DELIVERED BEFORE THE SOCIETY OF AGRICULTURISTS OF BERLIN FEBRUARY 17, 1888.

BY DR. OSKAR BREFELD,

Full Professor of Botany in Münster in W.

[Translated from *Nachrichten aus dem Klub der Landwirthe zu Berlin*, Nos. 220–222, by Erwin F. Smith.]

(*Continued.*)

As early as 1884 I began to make infection experiments on host plants, but soon, on account of the great number of details involved and the unimproved condition of my eyes, I was convinced that I could not carry through the experiments without assistance. Only upon my entrance into the Ministry of Public Instruction and transfer to Münster in Wesen was the help of an assistant in Mycology willingly granted me. This I had previously done without, having requested it of the Forest Department of the Ministry of Agriculture and been refused, although it was desired only as a compensation for my eye lost in direct government service. With this help, which I secured in the person of Dr. G. Istvanffi, privat docent in the University of Klausenburg in Hungary, I was able to bring the experiments to a relative conclusion.

But even four years ago I had carried on the culture of smut fungi in nutrient solutions for a long time, in order at least to make the first part of the investigations as complete as possible. I had cultivated the conidia of oat smut and corn smut from generation to generation for more than a year. Every four days the nutrient solutions were exhausted and the mass of yeast conidia was deposited in the culture as a distinct sediment. A few germs from the exhausted culture were always introduced by a needle-point into a new nutrient solution, and in another four days this was also exhausted. The serial cultures amounted to more than a hundred, which must have corresponded to about fifteen hundred continuous generations of the yeast conidia produced exclusively by sprouting. Yet the conidia produced in the last culture were of the same form as in the first. According to this, the sprout conidia in their unbroken succession are to be regarded as the exclusive product of the growth of these smut fungi in nutrient solutions *outside* of the host plants. This result is noteworthy in the same degree as the long-known fact that the smut spores are exclusively the form of the same smut fungi *inside* of the host plants.

Only this one change was to be observed in the continuous generations of the sprout conidia—they gradually pushed out into threads more slowly when the nutrient solution was exhausted. After ten months culture, after more than 1,000 sprout generations were formed, the germination in threads ceased entirely, the conidia swelled up somewhat and divided perhaps into two cells, but then remained passive. If we reflect that the conidia can penetrate into the host plants, to produce smut, only by means of their germ tubes, then with the disappearance of the tube germinations their infective power must also necessarily cease.

Consequently in the loss of this morphological character we have found a natural explanation for one of the much discussed special cases, viz, why the infective power of fungous germs should cease with lapse of time and with exclusive maintenance outside of the host. I will show later that as a matter of fact infections with these germs were without result, but first I will state briefly that in its composition and concentration the nutrient solution remained exactly the same during the entire period of the serial cultures; that therefore influences of nutrition and of the method of culture could not have brought about in the conidia the gradual cessation of thread germination.

The pure and satisfactory material from the sprout conidia of these smut fungi and of some others was also incidentally examined as to its possible power to induce alcoholic fermentation in nutrient solutions rich in sugar. But the forms investigated proved incapable of fermenting sugar, and could not grow at all in some of the larger masses of fluid. In these the sprouting remains nearly stationary and the germs finally die, probably from lack of sufficient access to air. From this behavior of the sprouts of the smut fungi in large masses of fluid

we can perhaps also judge of the behavior of the same germs in earth, and therefore in the soil of the field. It is scarcely to be supposed that the germs can be active in the deeper layers of the soil. It is much more probable that the condition for the vegetation of the smut fungi outside of the host plants is given only on the surface or in its vicinity, and that thence the host plants will be attacked by the smut germs.*

But, now, before I pass to the infection experiments, *i. e.*, to the production of smut diseases by infection with germs cultivated in nutrient substrata outside of the host plants, it may be judicious to state how extensive were the earlier experiments made directly and simply with the smut spores and to what results they have led.

When the smut spores dispersed in water were brought upon the surface of that part of the host in which in smutted plants the smut appears the result was purely negative; neither the penetration of the fungous germ into the plant, nor the subsequent sickening of the same, was to be observed. According to this the places where the smut shows itself in the full-grown host plants and the places where its germs penetrate into the plants could not well be the same. But neither on any other part of the full-grown plants was to be observed either the penetration of the germs or the subsequent appearance of the smut on the infected spots.

Following the earlier statements of Hoffmann it remained for J. Kühn of Halle, an eminent authority in the domain of Mycology and especially in that of smuts and smut diseases, to select young seedlings as the subjects for further experiments and observations. Kühn was the first who showed in the case of the stone smut of wheat the germ threads of the *Tilletia* in the young seedlings near the root node. Then he succeeded in doing the same thing in various forms of the genus *Ustilago*, after previous infection with the smut spores of these particular forms,—in *Ustilago maydis*, the corn smut, where three weeks after the infection he found a smut pustule in the young axis of the seedling, during the development of which the plant died; in *U. destruens*, *U. Crameri* and *U. Tulasnei*, on various kinds of millet seedlings (*Hirse-keimlingen*); and also in the dusty oat smut, *U. carbo*, and in *U. bromivora* on *Bromus secalinus*. In each case he was able to establish the existence of the mycelium of the smut fungus not only in the root node and its vicinity, but also in the first stem node and sheath-leaf node and in the internode between these and the root node. Also at the same time, in these parts, he saw distinctly the points of penetration of the fungous germs.

From his numerous experiments lasting many years, by which he

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* The experiments mentioned here upon the possible fermenting power of the smut yeasts, as well as the serial cultures themselves, were conducted with the most extraordinary care. The entrance of a single other yeast germ capable of causing fermentation would of course be enough to set up fermentation in the saccharine nutrient solutions and lead the experiments to wholly erroneous results.

also unquestionably showed the smut disease in the full-grown plants after previous infection of the seedlings, Kühn reached the conclusion that the regular way for a successful infection with smut fungi was through the axis of the host plant in the first stage of germination. Besides Kühn, R. Wolff also made successful infections with smut fungi in the botanical institute of De Bary in Halle. He repeated all the earlier experiments as to the places of penetration of the fungous germ into the host plants. In experiments which he made with *Ustilago carbo*, the dusty smut of oats, and *Urocystis occulta*, the stem smut of rye, he found that the germs of these fungi could not penetrate into the full-grown parts of the host plant; that only the *sheath-leaf* of the young, just germinating host plants, is susceptible and shows clearly places of penetration. In his experiments he sprayed his young plants with smut spores dispersed in water, making use of an atomizer to secure fine droplets, which alone would adhere to the surface. The plants were then kept moist under a bell glass in order to favor the germination of the smut spores on the surface and the penetration of the fungous threads. According to the conclusion which the author draws from the sum total of his experiments, the penetration of the fungous thread takes place in the young sheath-leaf of the seedling, and here only. The germs which have penetrated grow crosswise through the young leaves of the seedling till they reach their subsequent nidus of development. This permeating growth was also observed directly in *Urocystis occulta*.

Moreover in this fungus, and only in this, was observed the appearance of the smut in full-grown rye plants which were infected in their youth. To these results reached by Wolff, viz., that the sheath leaf of the young grain plant is the only place of penetration of the smut germ into the host plants, and that the germs grow crosswise through the young seedling and penetrate to the apex of growth—Kühn soon after replied with his complete array of proof, satisfactorily maintaining and additionally fortifying his earlier view. He points out that infection through the sheath leaf, which Wolff assumes to be exclusive, is uncertain, and that while in *Urocystis occulta*, according to his numerous and many-sided experiments, smutted rye can be produced by infection of the sheath leaf, this is not possible in *Ustilago carbo* on barley, in *U bromivora* on *Bromus secalinus*, and in forms in which the ovaries alone are smutted. He then sums up his experiences as follows: In all smut fungi which do not live in leaves, the result of infection through the sheath leaf is uncertain. Since these experiments by Kühn, which were made public in the Natural History Society in Halle in the beginning of 1874, no further accounts by other authors of infection experiments with grain smuts have appeared.

For my experiments, to the communication of which I now proceed, I chose the dusty smut, *Ustilago carbo*, on oats and barley, the millet smut, *U. cruenta* on *Sorghum saccharatum*, and finally the corn smut,

U. maydis on *Zea mays*. The first two smut forms will answer as types for smut fungi living solely in the grain, the last form as a type for smut forms which may appear not only in the grain but also in every part of the host plant, from the period of its earliest youth to complete development. All these forms belong to the genus *Ustilago*, and yield by the cultivation of their spores in nutrient solutions an endless sprouting of yeast conidia as experiment material.

The agriculturists, who listen to me, will perhaps ask themselves the question, Why not then make the experiments with the stone smut of wheat, the most important smut form upon the grains of this country? To this I will reply at once that stone smut was purposely neglected for reasons not far to seek. The stone smut of wheat, belonging to the smut genus *Tilletia*, is not a suitable object for experiment, first, because, as infective material, its conidia, cultivated in nutrient solutions and "reproduced mold-like in the air" can not be distributed so evenly and well upon the host plants, on account of their difficult dissemination and use in fluids, as can the the sprout conidia of the genus *Ustilago* which are developed under fluids; second, because in *Tilletia*, especially, the observation of the penetration of the germ into the host plant, and the further development of this within the host, is surrounded with the greatest difficulties on account of the extraordinary minuteness of the *Tilletia* germs and mycelia. Finally, it is yet to be added that in its appearance as a parasite, in the exclusive formation of the smut beds in the ovaries of the wheat, the stone smut agrees throughout with oat and millet smut, so that the results obtained in infection experiments with these plants will also unquestionably answer for the stone smut of wheat.

I will now first describe in detail the execution of the infection experiments and will add to this the results which were obtained in the different series of experiments with the isolated smut forms named.

In order to procure sufficient infective material, by the cultivation of smut spores in nutrient solutions, I proceeded in the following manner: Having the year before with the greatest care procured pure and ripe smut masses, I allowed single spores of *Ustilago carbo*, *U. cruenta*, and *U. maydis* to germinate in March or early in April in nutrient solutions on glass slides. After I was convinced, by exact observation, of the entire purity of the cultures and of the sprout conidia developed in them, I introduced a few of these conidia by means of a flamed needle into small, shallow flasks, with broad flat bottoms and short necks, constructed for the purpose, in which I had previously carefully sterilized thin layers of nutrient solutions. The sprout conidia so transferred which, in these flasks, were under the most favorable conditions for their increase by sprouting, exhausted the nutrient solutions in the flasks in three days' time and then accumulated on the bottom as a distinct precipitate. By samples taken out it was easily possible to convince one's self of the continued purity of the culture, because

the sprout conidia of the different kinds of smut fungi named always possess a definite and characteristic form, and intruding germs can be distinguished without difficulty. It was no trouble to keep unlimited quantities of these conidia, since a large number of these flasks for securing the material for infections were always prepared at the same time, in order subsequently to unite the sprout conidia out of these different flasks.

From the previously more fully described details as to the development of these fungi through the sprouting of their conidia, we now know that the multiplication ceases with the exhaustion of the nutrient solution, and that when this happens there immediately occurs a pushing out of the conidia into germ threads, which in turn, in the space of at most two days, lengthen out, but then cease to grow, and gradually perish. By means of these threads must the fungous germs penetrate into the host plants, when they begin to germinate upon their surface. Since the development into germ threads immediately stops the increase of conidia by sprouting, and since the germ threads, as they continue to develop, grow into the host plants, it follows that the sprout conidia must be transferred to the host plants, if the infection is to be attended with the best results, at a time when they are still sprouting and have not yet grown out into threads. The conidia which have already grown out into germ threads are very liable to injury by their transferrence to the host plants, and as soon as they have grown out are scarcely able to penetrate into the latter. The most favorable period for infection is very transitory in the rapidly growing conidia, and if it is missed, a normal success of the experiment is not to be expected. In view of this, the necessary precautions were taken to have the plants which were to be infected always ready in the various stages of development required for the individual experiments at the same time that the sprout conidia just described had reached their most favorable point of development for infection.

The transfer of the sprout conidia to the host or experiment plants was done with the help of an atomizer which Wolff had already used in his infections with smut fungi, and which I had myself formerly put to manifold uses in my mycological investigations. The sprout conidia from the different culture flasks were quickly united in one flask, in the neck of which the atomizer, cautiously tested for satisfactory performance, had been adjusted beforehand. Without the use of an atomizer it is impossible to bring the fungous germs upon the experimental host plants in the necessary degree of dispersion. Only in the tiniest drops do the sprayed fluids remain sticking to the parts of the plant upon which they have fallen; in case of larger droplets there occurs at once a union into drops which flow off, and consequently hinder the development on the plant and the penetration into it of the germs transferred with the droplet.

But it is now known that fungous germs are easily injured when taken in full vegetation and suddenly transferred from nutrient solu-

tions to pure water. They frequently die or, at all events, experience a weakening in their further development. In order to avoid these possible injuries to the sprout conidia of the smut fungi, I transferred the germs while still sprouting vigorously, from the culture flasks to the atomizer with the precaution to place in this first a diluted and sterilized nutrient solution. I knew to a certainty by previous experiments that in this the sprouting germs would not be injured, but rather would continue to sprout for a short time so far as the nutrient substances made this possible. In this way, it is true, a new source of error, the loss of time, is introduced, namely, the time in which the germs, sprayed upon the host plants by the atomizer, continue to sprout in the surrounding droplet before they grow out into germ tubes. However, without this error the experiment sometimes fails, because we can not spray into the host plant or administer to it the fungous germs in such ways as is customary in experiments with animals, but must apply them externally. The mixing of the fungous germs with the diluted nutrient solution in the atomizer can be regulated at pleasure according to the quantity of the germs. The mixture was always exactly tested before each experiment and not used until the trials each time had shown that at least thirty germs were present in the tiniest mist-like droplets.

The infection itself, to wit, the spraying with the fungous germs, was performed in shallow tin boxes made for the purpose. In this the nascent seedlings of the host plant were placed entirely uncovered, on soil from the field, and after the spraying, could be kept by means of a glass plate cover in a uniformly and suitably damp atmosphere at about 10° C. This was to hinder the evaporation of the sprayed droplets and at the same time to favor the development of the sprout conidia into threads and the penetration of these into the host plants. After 10 to 12 days the infected plants were set out in the open field, so as to make possible their full development and at the same time to give an opportunity for the development of smut in their spikes. But even with these very careful methods there were still serious obstacles to the success of the infection. The young seedlings exude, through stomata, especially at the apex of the shoot, drops of water which in running easily wash away the fungous germs which have been sprayed on, and in consequence may hinder their penetration and thus affect the result of the experiment. This and the already intimated sources of error in infections, *i. e.*, in the transference of the germs directly to the seedlings, make it probable at first sight that the infection will not succeed equally well in all the plants used for experiment, but rather that it will be successful only in a portion of these. But this indefinite per cent. of accidents is still further much increased by the circumstance that in the different forms of grain-smut the receptive stage in the seedling is so very transitory that (as later results of experiments show conclusively) only those fungous germs which penetrate into the just developed seedling above the root node, and in this

way reach the apex of growth, finally come to development in the heads of the grain; all others fail.

With this, we come to the penetration of the smut germs into the host-plants, so often vainly looked for until the investigations of Kühn and Wolff threw additional light upon the subject, and till Kühn proved the penetration into the young seedlings, especially in the vicinity of the root node. Wolff later announced and represented in his drawings the penetration exclusively into the sheath leaf. Both observers in their investigations had naturally worked only with smut spores germinating imperfectly and irregularly in water.

For my observations I first began with very young seedlings. As soon as the plumule appeared (and the roots usually preceded this by a day or two) these seedlings were laid free on the earth, sprayed with the atomizer, and then examined after several days' maintenance in suitably damp air. From all parts, from the apex to the root node, pieces of the epidermis were removed carefully and their surface examined for places of penetration. These were not to be found until the third day and were to be seen with most certainty on the fourth day; later they became gradually obscure. The spots at once attracted attention by a distinct hole in the epidermis. Beneath and inward from this hole, which was often of considerable size, extended always the intruded germ tube which had already grown crosswise through the superficial cell layers and disappeared with its apex in the deeper tissues. The influence of the nutrient material inside the cells of the host plant produced a marked effect on the germ tubes. The tubes here increased visibly in thickness and in vigorous appearance, and already in the deeper optical sections showed branches, which only very seldom appeared in germinations of the conidia in exhausted nutrient solutions.

In favorable preparations portions of the surface were found which appeared as if riddled by drill-holes and were completely permeated by the numerous ingrown germ tubes to a degree not possible to be observed, even approximately, with infective material previously employed. The more recent the places of penetration, the easier it was to see the superficial conidia in direct connection, through the epidermal opening, with the germ tube which had penetrated into the surface cells. After a time this picture lost in distinctness, in proportion as all parts of the fungous germ lying on the outside became empty and transparent and only the penetrated fungous thread bore contents. Still later the hole at the place of penetration disappeared and the germ threads in the outer cells lying near the place of penetration were transformed into delicate, empty threads, still to be recognized as fungous threads, only by the deeper union with normal portions of the tubes. I am inclined to believe that these rapid changes of the penetrated fungous threads take place because of the further growth and consequent stretching of the tissue of the seedlings, which were always infected in their earliest stages, long before they were full grown, and consequently before their

individual parts had reached full size. The fungus germs can follow this stretching of the tissue of the host plant only at their extremities, not in the remoter, older parts, which are incapable of intercalary growth, and which, consequently, being subject to strain, must be obliterated by being drawn out into threads.

Even in the next series of experiments in which older plants were infected; that is, somewhat older seedlings in which the sheath leaf was over a half inch long, but not yet broken through, the places of penetration occurred more rarely, and where they were to be seen many of the penetrated germ tubes had ceased to grow in the outer cell layers. They then exhibited an entirely different appearance, viz, a strong swelling of the membranes, which was often associated with a yellowish color. These objects had an unmistakable likeness to Wolff's drawings of the penetration spots, which the author has described as forming a cellulose sheath around the penetrating germ tubes. I have never seen such a sheath in normal cases of penetration and I consider it quite probable that Wolff only saw imperfect spots of penetration, with swollen germ tubes which he mistook for cellulose sheaths, because he confined his inflections solely to the sheath leaf in which, in somewhat older stages, the penetrated germ tube can not push in any further. (Wolff, *Brand des Getreides*, Halle, 1874.)

In order to follow up these observations I made repeated infection experiments with seedlings in which the sheath leaf was nearly full grown and was already broken through for half an inch by the following leaves. Here from the root node to the uppermost point I found no longer any normal spots of penetration. Very rarely a thread was found which had pushed through the two outer cell layers, then ceased its penetration and slowly perished with swelling of its membrane. At the same time there lay upon the surface hundreds of germinated conidia which could no longer penetrate, because the epidermis, fully formed in the meantime, was no longer permeable. The seedlings, therefore, in this stage of development already behaved toward the fungous germs exactly as do all parts of fully developed plants, into which, as is well known, the threads can not penetrate and in which they can not grow further.

Up to this point of the investigation, therefore, my observations confirmed, with some additions and amplifications, the earlier results of Kühn and some statements of Wolff. Nevertheless, it would appear to me that they only partially exhaust the question as to the place of penetration of the smut germ into the host plant, and that even the new proof material which supported the old idea hitherto generally accepted, that the smut germs must penetrate into the young seedlings in order later to produce smut in the full grown plants, is still insufficient and can not well be regarded as definitely concluding the investigation. For why should the penetration occur only in the young seedling which possesses no other disposition for it except the immaturity

of its tissues, which allows the penetration of the germ? Do not all incipient tissues of the growing tip of full-grown plants likewise exhibit this immature condition?

With our ordinary cereals further experiments did not, indeed, appear to be practicable on account of their small size. The growing tips of oats, barley, wheat, etc., are too small; it is here scarcely possible to bring the fungous germ into the still closed parts of the bud; the young ovaries are also too minute to work on with sufficient clearness of view. But I will nevertheless add that the penetration of fungous germs which I had here introduced into the heart of the growing point by means of the long drawn out point of a spraying flask, was established by direct observation and the threads of the penetrated germs could be seen in the leaves.

But the long series of experiments which I conducted with the larger cereals, corn and sorghum (*Hirse*), proved this much more convincingly. Here the tip is more open. The unexpanded leaves of the bud, folded one within another, open in the form of a large cornet into which we can spray with the syringe flask unlimited quantities of the nutrient solutions containing sprout conidia. These soak down deep between the closed leaves, and in corn, can even reach the growing tip itself with its young staminate panicle, in case the latter, in a somewhat advanced stage of development, has already pushed upward far enough in the bud. Furthermore, in corn the large adventive incipient roots on the lower part of the axis, and the pistillate spikes, particularly, which appear later upon the fully developed axis as sprouts in the leaf axils, offer excellent places of attack. Of course these experiments had to be made on large plants, or, in case of the infection of pistillate spikes, on nearly full grown ones, *in the open air*, where any other protection than a temporary covering with large straw mats was no longer possible.

In order, first, to consider the experiments with sorghum and *Ustilago cruenta*, its associated smut, I will add that I have infected in the heart more than 600 plants from 1 to 3 feet high, by simple injection of the fluid containing the sprout conidia. After four days the further developed portions of the growing point, in so far as they had come into direct contact with the infective fluid, appeared somewhat yellow. Upon superficial sections, the picture of the penetration of the fungous germs was a very clear one. The whole surface was covered with holes, from which big and luxuriant tubes extended into the inner parts of the young leaves, while through their influence was brought about obviously a faint yellowing, and later a more or less distinct wrinkling and shriveling of the attacked leaves. In thin cross-sections were to be found dozens of penetration spots cut through accidentally, while the fungous tubes grew through the entire tissue of the young leaves. That in this case only the young leaves were accessible to the fungous germs was shown on the older portions of the other leaves, which, though

richly covered with germinating conidia, did not show a single penetration spot.

The experiments with corn and corn smut were carried on still more comprehensively. Infections in the heart were first made on young plants about 6 inches high and showing an open apex, up to those of more than 2 feet in height. The appearances of penetrations were uniformly observed in all parts of the young leaves and young axes, in just the same manner except that on account of the size of the corn plants they were yet more distinct than in the sorghum. All the young leaves of the bud, and the still short and unexpanded parts of the axis lying between, were susceptible to penetration, as well as the tips of the axes with the staminate panicles, when the latter were reached by the spraying of the infective fluid. The penetrations also ceased here only when all parts of the bud passed from immaturity to full development. Concerning the adventive roots, and also the side sprouts of the pistillate spikes, which appear later and were infected in the bud, I can assert exactly the same thing as for the buds of the main axis; and, finally, I will state merely for sake of completeness, that also the scattering young hairs on the leaves, which are incipient in the very young leaves, are readily attacked by the fungous germs. Penetration spots were to be seen on these with especial distinctness.

After all possible places of attack by the smut germs have been discovered, there now remains to be added the results which were obtained in the subsequent production of smut upon the proper host plants with the specified smut fungi, by means of the various sorts of infection. This is done for the purpose of arriving at such conclusions as may be drawn with scientific authority in regard to the susceptibility of the host plants used in our experiments to smut diseases at different ages and stages of development, and on the appearance and spread of such diseases.

A. I begin with *Ustilago carbo*, the notorious dusty smut which destroys the fruit of oats, barley, wheat, etc. The smut spores germinate easily and produce sprout conidia in endless generations in nutrient solutions. In mass, the sprout conidia have a hyaline appearance. Their membranes become a little slimy on the outside, so that the germs can not lie together closely, but often form loosely connected heaps, which can again be easily dispersed in fluids.

The infections by dusty smut (*Flugbrand*) were carried on with barley and oats at the same time, and altogether considerably over one hundred series of experiments were made. In order to exclude sources of error, sowings of the uninfected grains were made for comparison, concerning which I will state, in brief, that they brought forth sound culms and fruit, only showing one smutty plant in two cases.

I. For the first series of experiments the grains were chosen particularly in the earliest stage of germination, where the rootlets had already come forth and the plumule was just visible. The tiny plants were placed upon the earth uncovered and were sprinkled all over with sprout

conidia from the atomizer. The culture remained about ten days in a room at 10° C., under cover in the tin boxes previously described and then the plants were set out in the field.

In ten experiments with oats, always with a sowing of 100 grains, the result was on an average 17 to 20 per cent. of smutty panicles. The infected barley remained entirely sound.

II. In the following series of experiments the grains which barely showed rootlets were placed on the earth and so covered with a thin layer of soil, at most ¼cm. thick, that only the emerging points of the seedlings were exposed and were infected by means of the atomizer, consequently the infection only reached the sheath leaf. The shoots were infected in the youngest stage when they had pushed out of the earth about ¼cm.

In seven experiments with oats, each of 100 grains, the result was not more than 5 per cent. of smutty plants. The barley remained entirely sound.

III. The infection was made as in I on uncovered plants, the shoots of which were about 1½–2cm long, but did not yet show any opened sheath leaf.

Here in eight experiments with oats the result fell back to 2 per cent. of smutty plants; barley sound.

IV. Infection as in II, the sheath leaf only infected, the remaining parts of the seedlings covered with soil, but the shoot of the same length as in III.

In three experiments with oats there was 1 per cent. of smutty plants; in two experiments none were obtained; barley sound.

V. Infection of uncovered seedlings with sheath leaf already pushed through.

In two experiments with oats the result was 1 per cent. of smutty plants, in two others, none; barley sound.

VI. Experiments with infected soil in which the unsprouted grains were sown.

In five experiments with oats the result amounted 4 to 5 per cent. of smutty plants; barley sound.

VII. Experiments with an abundantly infected mixture of soil and fresh horse dung, in which the unsprouted grains were sowed.

Here in three experiments with oats the result rose to 40 to 46 per cent.; in three additional experiments, which were not conducted in a cool room, there was 27 to 30 per cent. of smut; barley again entirely sound.

VIII. Experiments with conidia, which had been cultivated ten months, generation after generation, in nutrient solutions, and which ceased to grow out into threads after the exhaustion of the solutions, infection of young seedlings lying uncovered on the earth in first stage of germination, as in I.

The result was negative. In two series of experiments there was in

one case 1 per cent., in the other 2 per cent. of smutty plants; in two additional series no smutty plants; barley sound.

IX. Experiments with larger plants by external infection and by infection in the heart of the growing tip, were wholly without result.

The final result of the experiments with oats may be summed up as follows: The infection most productive of results is upon the barely germinating young seedlings, just as it was previously stated by Kühn. The exclusive infection of the sheath leaf is fruitful, as a rule, only in the youngest stages of the same. The infection is without result as soon as the inner leaves have pushed through the sheath leaf more than 1cm.; from this point on the plants are proof against the fungous germ. By the use of nutrient substrata for the conidia sproutings, consequently by means of earth treated to fresh horse dung, the infection of the young seedlings will be greatly increased and the spread of the smut very materially promoted,* corresponding to the experience of husbandmen in the use of fresh dung in the field. Smut germs, which have lived too long and too exclusively outside of the host plant and multiplied in the form of sprout conidia, lose their infective power conjointly with the ability to throw out germ tubes.

But how are the negative results of the experiments to be interpreted? *First*, how is it to be explained that even in the most favorable cases only a large per cent. of the experimental plants become smutty and not all which were infected? And, *second*, whence comes it that in all experiments with barley in not one single case did a plant become smutty?

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* The influence of fresh dung on the production of grain smuts diminishes quickly with the age of the dung, because the conidia germinated in it perish, and in old rotten dung the smut spores develop imperfectly or not at all. The less wet the dung the more slowly decay takes place, and the longer the smut germs can maintain themselves in it.

In the dung of horses, and of swine also, are to be found many oat and barley grains which have not been digested and which subsequently germinate in the dung. Many times by the hundred in root fields I have come across such germinated barley grains, accidentally transported into the field with the fresh swine dung, and have found that for the most part they bring forth smutty spikes. This bears most striking witness to the effect of *fresh* dung in the spreading of smut and in the appearance of smut in *freshly manured* fields. In isolated cases, in small fields, I have gathered the smutted spikes in thick bundles, and have found that out of 100 barley plants were to be found only 10 to 15 sound spikes. It need not be said that in these cases I have each time inquired very exactly and particularly concerning the way of manuring.

PRELIMINARY NOTES ON A NEW AND DESTRUCTIVE OAT DISEASE.

By B. T. Galloway and E. A. Southworth.

During the months of May and June we received repeated complaints and inquiries concerning a mysterious oat disease which then threatened to destroy the entire crop of the eastern and central States.

During the month of May, when the oats were from 6 inches to a foot in height, the leaves suddenly began to turn brown and die at the tips. The lower leaves were attacked first and the brown color soon extended their entire length. In a very short time all the leaves were dead, or partially brown, and the prospects were that the plants would die and the oat crop be a total failure. About the middle of June, however, the fields began to revive, the oats put out some few fresh green leaves, most of them headed out, and by the first of July many of the fields appeared in a fair condition on superficial observation. In reality, however, the losses from the disease will amount to from 35 to 75 per cent. of the crop, according to the locality. Very discouraging losses are reported from the State of Pennsylvania, where there is probably not a healthy oat field to be found. Kentucky and Tennessee have suffered even more, their present averages as reported to the Statistical Division being the lowest ever reported from any State for a staple crop.

The disease extends from New England to Georgia, and from the Atlantic coast as far west as Indiana and Illinois. It is not present in Michigan. All the agents for the Statistical Division agree in ascribing the cause of this remarkable decline in the oat crop to the same thing, namely, a "blight" or "rust" which struck the fields in May.

The disease prevented the oats from stooling well, and it frequently happened that all the shoots but the main one of a stool were killed. As a result the oats are very thin, and in riding along by a field even at a considerable distance one can see to the ground between the drill rows when the oats are in full head. Besides this the losses are augmented by the fact that the amount of green foliage which developed after the attack was not sufficient to produce a strong growth of the surviving stalks, nor to supply material for a good-sized head; the straw is therefore short and light and the heads small. The heads do not seem to be well filled, and threshing will probably reveal a lighter yield than farmers themselves expect.

Such a universal disease can be attributed to no deterioration of soil or lack of cultivation, although there is no doubt that good cultivation will produce better oats than poor, even when they are diseased. The disease has attacked oats on the best as well as on the poorest soils, fields that were fertilized as well as those that were not. The oats are best, however, in level well cultivated and well drained fields, while they are poorest in low, wet spots and on hillsides and other

places where the soil is thin. In such places they are too short to be harvested.

A very careful study of the plants has been made in the field and laboratory, but nothing in the way of a fungous or animal parasite that could cause the trouble has been found. From the nature of the disease our attention has been directed mainly to a study of it from a bacterial standpoint. Bacteria have been found in every specimen examined. Nearly 200 cultures have been made in at least a dozen different media and all have yielded two germs, one of which is exceedingly abundant. In nearly 50 cases the disease has been produced in young pot-grown plants by inoculating from direct material. Inoculations of young plants with pure cultures are now under way and it is hoped that some definite results will soon be obtained from this source.*

There is still a possibility that although the disease may be caused by bacteria they are dependent upon certain conditions of the atmosphere for their development, and need not be feared another year. Experiments to settle this question are also under way.

COPPER-SODA AND COPPER-GYPSUM AS REMEDIES FOR GRAPE MILDEW.

BY J. NESSLER.

(Translated from Biedermann's Centrall-Blatt for April, 1890, by Gerald McCarthy, N. C. Experiment Station.)

For several years preparations of copper-soda and copper-lime have been employed for mildew of the grape with good success. Neither of these preparations do any injury to the sensitive parts of the vine. The copper-soda mixture neither clogs the openings of the sprayer nor interrupts the spray by foaming; moreover, it sticks to the leaves very well. With this mixture the granular deposit is formed less rapidly the first day, but after that more rapidly than is the case with the copper-lime mixture. Sulphate of copper is decomposed equally well by soda and by lime. The granular deposit takes place sooner or later, according to the method of preparing the mixtures. Once formed, the pulverulent mass returns to its former state very quickly after being stirred, and on this account it is liable to clog the opening of the sprayer. More particularly is this the case when the lime used is not very finely divided or the copper solution is not sufficiently diluted. One should therefore use in mixing only a perfectly homogeneous lumpless lime-cream and copper solution so dilute that little or no additional water

* Since writing this the disease has been produced in fifty or more cases by inoculating with the more abundant organism. Five days after inoculating, the characteristic discolorations appeared, and cultures made from these have yielded the typical organism in a nearly pure condition.

need be added before using. Neither mixture should be kept more than one day before being used. The lime gradually precipitates the copper in needle-shaped and granular particles, which very quickly clog the spraying-nozzle. The copper-soda solution after a short time becomes wholly unserviceable on account of the granular deposit. The more or less rapid formation of the deposit depends on the strength of the solution in soda. If, for example, one uses 4½ pounds sulphate of copper and 5¾ pounds of soda, the deposit takes place in eight or ten hours, whereas by using only 5 pounds of soda the solution remains serviceable for twenty-four hours or longer.

In using the copper-lime and copper-soda preparations one should observe the following rules:

(1) The lime must be reduced to a homogeneous lumpless cream.

(2) Both the lime-cream and soda solution must be added only to a very dilute solution of copper sulphate. Indeed this should be so dilute that no subsequent addition of water will be necessary.

(3) Although a larger amount of lime than is necessary may be added without injury to the foliage of the plants, yet according to the quantity of the lime used will be the rapidity with which the pulverulent precipitate is formed. Any surplus of soda will injure the foliage.

(4) The mixture must not be stored, but used immediately after it is prepared.

If one has water handy to the field it may be more convenient and expeditious to prepare at the house strong simple solutions of copper sulphate and soda, and dilute them afterwards in the field. One may, for example, wet 2 pounds 3 ounces copper sulphate with 1¼ gallon of water and 2 pounds 9 ounces soda with the same quantity of water, and for this purpose hot water is the best. Twenty-six ounces of burnt lime or 5½ pounds of air-slaked lime will produce 1¼ gallon of lime-cream. For the production of the final mixtures dilute 2½ gallons of the copper solution to 26 gallons and add 2½ gallons of the soda solution or the same quantity of the lime-cream. Weak mixtures act about as well as strong ones, and instead of 4½ pounds copper sulphate, one may use only 2 pounds 3 ounces. In place of 5 pounds of soda, 2 pounds 9 ounces may be used. But where the weaker mixtures are employed, it is recommended to spray somewhat more copiously.

The author has also experimented with a dry powder composed of 10 parts copper sulphate, 10 parts burnt lime, and 100 parts calcined gypsum.

Spraying with liquids is preferable to dusting with powders, because in liquid form the copper is more divided and sticks longer to the leaves; the effect being therefore more permanent. On the other hand the powder is very convenient in cases where an effective spraying apparatus is wanting and in situations where water is difficult to procure. Moreover the powder can be applied by women; the liquids can not.

NOTE ON A MINNESOTA SPECIES OF ISARIA AND AN ATTENDANT PACHYBASIUM.

By CONWAY MAC MILLAN.

Early in April Mr. E. P. Sheldon found on the river bank below St. Anthony's Falls, Minn., a pupa of Orgyia leucostigma, commonly known as the Tussock moth, which was covered with a growth of *Isaria*. The fungus does not correspond to any described species in all its characteristics, though I have determined it provisionally as *Isaria sphingum*, Schw., which is the conidial form of *Cordyceps sphingum*, (Tul.). The description of the Minnesota form is appended:

Stromata gregarious; 1½ to 3 centimeters high, ½ millimeter thick, and slightly subclavate, arising from a pulverulent-granulose, yellowish mycelium, conidial area but slightly thickened, hyphæ 4μ in thickness, indistinctly yellowish, conidia very minute, ovoid, 1½–2 by ½–1½μ; hyaline, deciduous.

This does not coincide exactly with the description of *Isaria sphingum*, Schw., given in Saccardo's *Sylloge Fungorum*, but in the genus *Isaria*, and throughout many of its allies exact descriptions are not attainable, owing to the failure of the older mycologists to measure hyphæ and spores as well as stromata and conidial areas.

An effort to cultivate this species of *Isaria* was made.

Portions of conidial areas were removed with sterilized forceps, and were then placed, with every precaution, in gelatine culture tubes. Some of those, prepared by Dr. George Grübler, of Leipsig, happened to be at hand and were chosen for three cultures. Repeated experiments showed that, together with adventitious forms—*Macrosporium* in one case and *Piptocephalis* in another—a very peculiar plant, clearly of the genus *Pachybasium*, Sacc.—was constantly developed in the gelatine tubes. This *Pachybasium*, distinguished by its bottle-shaped (*ampulliform*) basidia, whorled along the fertile hyphæ, as in *Verticillium*, Nees., is possibly *P. hamatum*, (Bon.) Sacc., described in the *Sylloge Fungorum* Vol. IV, pp. 149, 150. Since, however, the Saccardian description lacks measurements, a description is appended.

Forming minute yellowish patches on gelatine, becoming grayish or greenish-white, fertile hyphæ 3½–4 μ. in thickness, 40–90 μ. in length; ascending with whorls of basidia, either directly attached or with secondary branches interpolated; basidia shortly ampulliform, necks constricted, conidia ovoid 1½–2 by ½–1½ μ., clinging persistently to the basidia.

It will be seen that measurements of the spores and hyphæ of this *Pachybasium* correspond exactly with those given above for the *Isaria*, and this fact, together with the appearance of the former so uniformly in connection with the latter, might tend to give the impression that the two genera are pleomorphous and that in *Pachybasium* we have another step in the life history of *Cordyceps*. It is well known that

Isaria gives rise to peculiar forms in gelatine cultures; for example, according to Alfred Giard, reported in the JOURNAL OF MYCOLOGY, Vol. V., p. 174, *Isaria destructor* assumes the form of *Coremium*. *Coremium* is, however, a genus of *Stilbeæ* very close to *Isaria*, while *Pachybasium* is in the *Mucedineæ*. By the plate-culture methods it is hoped that absolutely pure cultures of the *Isaria* may be obtained, and if there is this genetic connection between *Pachybasium* and *Isaria* it may then become capable of demonstration. The preceding note is intended simply to direct attention to the fact that *Pachybasium* has been distinguished in American habitat, and that it may be looked for in connection with *Isaria sphingum*, Schw. on gelatine cultures of the latter form.

UNIVERSITY OF MINNESOTA.

A FEW NEW FUNGI.

BY J. B. ELLIS AND S. M. TRACY.

PHYLLACHORA STENOSTOMA, *n. s.* On leaf of *Panicum brizanthemum* from Africa. Com. Prof. S. M. Tracy. No. 501. Stromata innate, only slightly prominent, black, rather indefinitely limited, subelongated, 1–2 millimeters long, punctate from the slightly prominent hysteriiform ostiola. Ascigerous cavities small, subglobose, numerous. Asci subfasciculate, sessile, oblong cylindrical, 40–45 by 7–8μ. Sporidia biseriate, oblong, 1-septate and slightly constricted at the septum, yellow-brown, 12–15 by 3–3½μ. Bears a general resemblance to *P. graminis*, but less prominent, sporidia different besides in the narrowly compressed ostilum which resembles a minute *Hysterium*.

FUSARIUM CELTIDIS, *n. s.* On fruit of *Celtis occidentalis*, Starkville, Miss., May, 1890, Tracy, 1333. Sporodochia scattered, erumpent, pulvinate, pale orange, ¼–1 millimeter in diameter. Basidia subfasciculately branched above, branches erect, 40–60 by 4μ, septate. Conidia fusoid, nearly straight, only the obtusely pointed ends slightly curved, 5 septate, 40–60 by 4–5μ.

CLADOSPORIUM VELUTINUM, *n. s.* On *Phalaris Canariensis*, Starkville, Miss., March, 1890. Forming velutinous, olive-brown patches ½–1 centimeter long, or by confluence longer, slightly thickening and distorting the leaf; hyphæ erect, simple, septate, subundulate, pale brown, 50–75 by 4–5μ; condia terminal, 8–20 by 4–5μ, 1–3-septate, subhyaline, the shorter ones elliptical, the longer ones oblong or cylindrical.

PUCCINIA APOCRYPTA, *n. s.* On *Asprella Hystrix*, Cañon City, Colo., Tracy, August, 1887. Hypophyllous, sori oval or oblong, occupying the entire under surface of the lower leaves and remaining covered indefinitely by the epidermis; uredospores oval, epispore thin, minutely

roughened, 20–22 by 23–26μ; teleutospores clavate or oblong, not constricted, thickened above, usually truncate with a broad flat apex but often pointed or irregular, narrowed below, smooth, 14–18 by 42–55μ; pedicel very short. Allied to *P. coronata*, Cda., but the terminal processes are either wanting or only rudimentary.

UREDO PERIDERMIOSPORA, *n. s.* On *Spartina glabra*, Ocean Springs, Miss., Tracy, September, 1889. Epiphyllous, sori linear, near the base of the leaf, long covered by the remains of the ruptured epidermis; spores bright red, pyriform, echinulate, much thickened at the apex, 19–22 by 36–45μ; pedicel short but distinct.

UREDO NYSSEÆ, *n. s.* On *Nyssa capitata*, Jackson, Miss., Tracy, November, 1888. Hypophyllous, sori minute and scattered over the entire under surface of the leaf, but not confluent; spores globose to pyriform, epispore thin, minutely echinulate, 12–15 by 15–30μ.

USTILAGO BUCHLOËS, *n. s.* On leaves of *Buchloë dactyloides*, Cooledge, New Mexico, June, 1887. Sori cylindrical, mostly about 1 centimeter long and 2 millimeters thick, covered by a thin gray membrane and filled with the black, subglobose, very minutely echinulate-roughened spores, 12–15μ in diameter. The sori occur on either side of the leaf, mostly near the tip, and resemble miniature sausages; sometimes two being found exactly opposite each other on the same leaf.

CINTRACTIA AVENÆ, *n. s.* On *Avena elatior*, Starkville, Miss., July, 1889. Transforming the ovaries into a compact black mass about as large as a small shot, made up of compact masses of subglobose spores 5–6μ in diameter, hyaline at first, brown at maturity; epispore smooth and comparatively thin.

SOROSPORIUM GRANULOSUM, *n. s.* On *Stipa viridula*, Trinidad, Colo., Tracy, June, 1887. Involving the entire flower-spike, which becomes so aborted that it barely opens the sheath of the upper leaf; spore masses globose or irregular, 50–75μ in diameter, composed of 20–50 smooth, globose, or by pressure irregular spores, 14–16μ.

USTILAGO HILARIÆ, *n. s.* On *Hilaria Jamesii*, Albuquerque, N. Mex., Tracy, June, 1887. Involving the entire flower-spike, and forming a compact cylindrical or ovate mass ½–1 by ¼ centimeter, inclosed in a thin gray membrane; spores oval, brown, sharply echinulate, 10–14 by 12–15μ, or globose; 12–12μ. *U. cylindrica*, Pk. has smaller spores.

USTILAGO OXALIDIS, *n. s.*, N. A. F. 2424. Starkville, Miss., Tracy, May, 1888. In ovaries of *Oxalis stricta*, filling the entire ovary with a mass of reddish-brown spores; spores globose, 10–12μ; epispore rather thick, sharply echinulate.

COMBATING THE POTATO BLIGHT.

By J. H. Bünzli.

[Translated from Biedermann's Centrall-Blatt for April, 1890, by Gerald McCarthy, N. C. Experiment Station.]

The use of preparations of copper sulphate as a means of checking the potato blight has in practice proved a brilliant success. The experiments made by the author in the years 1887 and 1888 indicate clearly that potato-growers should not begrudge the small expense of applying the remedies if they aim at extensive cultivation of the potato plant. The fungicides employed in the above mentioned years were as follows:

(1) Bordeaux mixture: 17 pounds 10 ounces copper sulphate; 33 pounds lime; 34 gallons water.

(2) Copper-soda solution: (*a*), 2 pounds 3 ounces copper sulphate; 3 pounds 5 ounces soda; 26 gallons water; (*b*), 4 pounds 6 ounces copper sulphate; 6 pounds 10 ounces soda; 26 gallons water.

(3) Azurin (prepared after Morgenthaler's formula).

(4) Poudre Coignet.

For the first treatment, made before the flowers fell, the author used the preparations 1, 2*a*, 3, and 4, there being one plot for each solution. The plots were so arranged as to give to each the same exposure, fertility and texture of soil. Soon after the observation was made that wherever the azurin was used the result was unsatisfactory. The Bordeaux mixture gave quick results, but its manipulation was difficult. Under the circumstances the author concluded to use a stronger solution of No. 2*a*, and at the second spraying of the vines employed solution No. 2*b*. The Poudre Coignet was laid aside, as it was found to be of no service whatever, and besides badly burned the leaves and stems.

Plot 1 was sprayed the second time with a dilute solution of the Bordeaux mixture, viz: 6 pounds 10 ounces copper sulphate, 6 pounds 10 ounces lime, and 26 gallons of water. Plot 3 received azurin again. This second application was given at the beginning of August, but soon afterward, in spite of the Azurin, the plot was found badly affected. Part of the plot was immediately resprayed with solution No. 2*b*, but with only partial success, because the blight had already secured such an advantage that it could not be dislodged. Nevertheless the supplementary treatment showed some effect. In each treatment the author aimed to use upon one acre (*juchart*) 53 gallons to 79 gallons of fluid, put on with an efficient sprayer so that the liquids were well distributed on both sides of the leaves, insuring more complete adhesion and less risk that the material would be all washed off by the first rain.

Although the weather was copiously moist, with the inevitable result of dissolving away the protective materials used, the plots treated with the Bordeaux mixture and copper-soda solutions were still green at the

beginning of September, while on all the other plots the vines were completely dried up. Where the soda solution had been used the leaves and stems appeared large and fine; where the copper lime mixture had been used the leaves and stems were considerably smaller.

The harvest gave the following results:

Plot 1 (Bordeaux mixtures).—Three-fourths average yield of sound tubers. The tubers were small but solid. Few were diseased.

Plot 2 (Copper-soda solutions).—Full average yield of sound tubers, besides some diseased ones. None were rotten.

Plots 3 *and* 4 (Azurin and Poudre Coignet).—One-fourth an average yield. On Plot 3, where the solution 2*b* had been used, the harvest was two-fifths of a full yield.

The author's experience leads to the conclusion that potato fields should be sprayed twice—the first spraying about July 1, the second about August 15. For early varieties the treatments should be earlier. The author especially recommends, in the order given, solution 2*b*, and the Bordeaux mixture reduced to 6 pounds 10 ounces copper sulphate, 6 pounds 10 ounces lime, and 26 gallons of water.

MUCRONOPORUS ANDERSONI, *n. s.*

By J. B. Ellis and Benjamin M. Everhart.

Under the bark of an oak log, Newfield, N. J., April, 1890. Found by Mr. F. W. Anderson, to whom the species is dedicated. Effused, immarginate, entirely concealed by the bark which is finally thrown off, 20 or more centimeters long and 5 centimeters broad. Pores about half a centimeter long and ⅓ millimeter in diameter, marginal ones broader and shorter, margins acute, nearly round, chestnut color, stained yellowish by the sulphur-yellow spores, (5–6 by 4–5μ), which are discharged in great abundance, coloring the inner surface of the bark and escaping through the cracks in the bark in such abundance as to cover the leaves and other things near with a bright sulphur-yellow coating. Spines not very abundant, conical at first, then elongated to 15–25μ long by 6–7μ thick.

The subiculum from which the pores arise is very thin, so that they penetrate almost to the wood. The hymenium when fresh is very soft and pliable and the walls of the pores contract in drying, so that they are often torn from their attachment below and the hymenium becomes very much cracked.

The yellow coating of spores discharged on the bark constitutes the so-called "*Chromosporium pactolinum*, Cke. & Hark." (*C. vitellinum*, S. & E. in Syll.,—*C. Isabellinum*, in N. A. F., 1391.)

INDEX TO NORTH AMERICAN MYCOLOGICAL LITERATURE.

By David G. Fairchild.

15. Bailey, L. H. **Damping off.** American Garden, Vol. XI, No. VI. June, 1890, p. 348. Thinks disease due to "potting-bed fungus," and recommends preventive remedies.

16. Benton, L. E. **A Japanese plum disease** (with figure). Pacific Rural Press, May 17, 1890, Vol. XXXIX, No. 20, p. 505. *Taphrina pruni*, Tul., on imported species of plum.

17. Bessey, C. E. **The diseases of farm and garden crops.** No. I. Announces series giving list of diseases to be spoken of. Nebraska Farmer, January 30, 1890, Vol. XIV, No. 5, whole No. 402, p. 89.

18. ——— No. II. **Black knot** [*Plowrightia morbosa*, (Schw.) Sacc.]. *Ibid.*, February 13, 1890, Vol. XIV, No. 7, whole No. 404, p. 129. Gives popular life history with recommendation to cut and burn diseased parts.

19. ——— No. III. **Stinking smut** [*Tilletia fœtens*, (B. & C.) Trel.]. *Ibid.*, February 13, 1890, Vol. XIV, No. 7, whole No. 404, p. 130. Defines "smut," gives means of propagation, and recommends blue-vitriol solution for seed-wheat.

20. ——— No. IV. **Grain smut** [*Ustilago segetum*, (Bull.) Dit.]. *Ibid.*, February 20, 1890, Vol. XIV, No. 8, whole No. 405, p. 151. Recommends rotation in crops to prevent continuance of disease.

21. ——— No. V. **Corn smut** [*Ustilago maydis*, (DC.) Corda]. *Ibid.*, February 27, 1890, Vol. XVI, No. 9, whole No. 406, p. 165. Notes injury from disease and danger of using manure from animals fed with smutty corn.

22. ——— No. VI. **Sorghum smut** [*Ustilago sorghi*, (Link.) Pass]. *Ibid.*, Vol. XIV, No. 10, whole No. 407, p. 189, March 6, 1890. Notices appearance of smut on Mill's maize in Nebraska and Wisconsin; recommends bath of blue-vitriol water for seed.

23. ——— No. VII. **The strawberry leaf-spot** (*Ramularia Tulasnei*, Sacc.). *Ibid.*, March 15, 1890, Vol. XIV, No. 11, whole No. 408, p. 209. Discusses removal of all leaves in fall, as preventive measure.

24. ——— No. VIII. **Grain rust** (*Puccinia graminis*, Pers., and other species). *Ibid.*, March 27, 1890, Vol. XIV, No. 13, whole No. 410, p. 250. Gives life history with well-known means of preventing spread.

25. ——— No. IX. **The rust of the Indian corn** (*Puccinia sorghi*, Schw.). *Ibid.*, April 10, 1890, Vol. XIV, No. 15, whole No. 412, p. 293. Recommends all uncut fodder to be burned, thus preventing wintering of fungus.

26. ——— No. X. **The raspberry stem fungus.** *Ibid.*, April 24, 1890, Vol. XIV, No. 17, whole No. 414, p. 333. Refers to destructiveness, with general means of combating the fungus.

27. ——— **Seymour and Earle's economic fungi.** American Naturalist, March, 1890, Vol. XXIV, No. 279, p. 277. Remarks usefulness of the publication.

28. ——— **Ellis' North American fungi.** American Naturalist, March, 1890, Vol. XXIV, No. 279, p. 277. Short comment on quality of the work.

29. Billings, John S. **Some tiny fungi.** Youth's Companion, Vol. 63, No. 20, May 15, 1890, p. 272. Notices bacteria, fermentation, fungus on tomato.

30. Bolley, H. L. **Note on the wheat rust.** Microscopical Journal, March, 1890, Vol. XI, No. 3, p. 59. Discusses question of other host than Barberry for the æcidium of *P. graminis*. Notes possible infection through sporidia or dissemination of early formed uredospores. Expresses opinion that neither *P. rubigo-vera*, (D. C.) Wint., nor *P. graminis*, Pers., are truly perennial. Suggests questions in regard to winter life and identity of *P. rubigo-vera* with European species.

31. Chester, F. D. **A botanical description of the black-rot of the grape** (with figures from Ann. Rept., Section of Vegetable Pathology, 1886). Second Annual Report of Delaware Agricultural Experiment Station, 1889, issued February, 1890. Presents in concise popular form the results of investigations of Section Vegetable Pathology, and others, into life history of *Læstadia Bidwellii*, (Ellis) V. & R.

32. ——— **Peach yellows, culture tests.** *Ibid.*, pp. 92–94. Shows complete failure of attempts to produce bacterial colonies in peach-wood infusions or nutrient gelatine from portions of the inner bark of diseased twigs.

33. ——— **The black-rot of the grape controlled by Bordeaux mixture.** *Ibid.*, pp. 79–87. Offers results of experiments in 1889 on vineyard of 1199 vines, near Smyrna, Del.

34. ——— **Spraying with sulphide of potassium for the scab of the pear.** *Ibid.*, pp. 88–91. Reports successful experiment near Newark, Del., upon the fruit of fourteen pear trees attacked by *Fusicladium pyrinum*, Fckl. Same found in Bull. Del. Ag. Ex. Sta. VIII, March, 1890, p. 11.

35. ——— **Diseases of alfalfa.** *Ibid.*, pp. 94–97. Notices *Phacidium medicaginis*. Lasch., and describes as new *Cercospora helvola*, Sacc., var. *medicaginis*, on *Medicago sativa*, with original figure.

36. Curtiss, George G. **Treatment of bitter-rot of the apple.** Bull. 11, Sect. Veg. Path., U. S. Dept. Ag., p. 38. Reports successful treatment of *Glœosporium fructigenum*, Berk., with potassium sulphide and ammoniacal copper carbonate solutions. Prefers latter solution.

37. Earle, F. S. **Experiments with fungicides for plant diseases.** Bull. 11, Sect. Veg. Path., U. S. Dept. Ag., p. 83. Notes injury to peach and plum leaves from Bordeaux mixture applied for rust (*Puccinia pruni*, Pers.).

38. Ellis, J. B., and Everhart, B. M. **Notes on a species of Coprinus from Montana** (with Plate IV). The Microscope, May, 1890, Vol. X, No. 5, p. 129. Describes and figures *Coprinus sclerotigenus*, E. & E., as new, from Great Falls, Montana.

39. Galloway, B. T. **Report on the experiments made in 1889 in the treatment of the fungous diseases of plants.** Bull. 11, Department of Agriculture, Section of Vegetable Pathology. Contains reports on diseases of grape, apple, quince, pear, plum, peach, melon, potato, tomato; with reports of Goff, Howell, Holliday, Jaeger, Scribner, Earle, and Pearson, also summary of volunteer reports on treatment of grape diseases, and announcement of new fungicides, translated from Italian of Comes & Deperais.

40. ——— **Notes on the fungus of apple scab.** Bull. No. 59, Mich. Ag. Exp. Sta., April, 1890, p. 27.

41. ——— **Pear leaf blight** (with fig.). Proc. 15th Ann. Meet. Am. Ass'n. of Nurserymen, 1890. Gives description of *Entomosporium maculatum*, Lév., with latest methods of treatment.

42. Goff, E. S. **Treatment of apple scab** (with Plate I). Bull. 11, Sect. Veg. Path., U. S. Dept. Ag., p. 22. Gives successful results of experiments on twelve trees with potassium sulphide, sodium hyposulphite, Bean's sulphur powder, ammoniacal copper carbonate, and Bean's liquid sulphur preparation. Decides in favor of ammoniacal copper carbonate.

43. ——— **Prevention of apple scab** (with fig.). Bull. 23, Univ. of Wisc., April, 1890. Reports experiments made in connection with Sect. Veg. Path. in 1889. Reported in Bull. 11 of the Section of Vegetable Pathology, Dept. Ag.

44. ——— **Prevention of apple scab**, *Fusicladium dendriticum*, Fckl. The Prairie Farmer, April 19, 1890, Vol. 62, No. 16, p. 246. Describes use of fungicides in treatment of the disease.

45. Halsted, B. D. **Why not legislate against the black knot.** Garden and Forest, April 16, 1890, Vol. III, No. 112, p. 194. *Plowrightia morbosa*, (Schw.) Sacc. is

45. HALSTED, B. D.—Continued.
noted as being from its character easily legislated against. Thinks the law should be made to include wild plum and cherry trees.

46. ——— **Anthracnose or blight of the oak.** Garden and Forest, June 18, 1890, Vol III, No. 121, p. 295. The *Glœosporium nervisequum*, (Fckl.) Sacc., attacking *Platanus occidentalis*, described in the JOURNAL OF MYCOLOGY, Vol. 5, No. II, is found causing great damage to the leaves of white-oak trees near New Brunswick, N. J. It is recommended to cut down the affected trees to check the spread of the disease.

47. ——— **Legislation against fungous diseases.** Garden and Forest, June 25, 1890, Vol. III, No. 122, p. 307. Gives copy of law of New Jersey enacted May 23, 1890, authorizing destruction of all plants which in the opinion of the officers of the State Experiment Station are so diseased as to threaten injury to agricultural interests. Owners of diseased plants to be recompensed by State. Notices, in connection, *Peronospora rubi*, Rabenh., upon cultivated raspberry, as being new to this country.

48. ——— **Nematodes and the oat crop.** Garden and Forest, July 2, 1890, Vol. III, No. 123, p. 319. Notices presence of bacteria in diseased oat plants without determination as to pathogenic nature. The presence of abundant nematodes in the small roots is thought a possible cause. Refers to articles of Comstock, Atkinson, and Neal on nematodes, and mentions possible preventive measures to be taken.

49. ——— **Anthracnose on the maple.** Garden and Forest, July 2, 1890, Vol. III, No. 123, p. 325. Mentions a tree of *Acer rubrum* standing near an oak attacked with *Glœosporium nervisequum*, (Fckl.) Sacc., as having been badly diseased with the same fungus.

50. ——— **Sweet-potato soil-rot and other forms.** Rural New Yorker, April 19, 1890, Vol. XLIX, No. 2099, p. 249. Notices "ground-rot" similar to clover sickness; soft rot due to a *Mucor;* black-rot, stem-rot, and white-rot, giving popular descriptions of the various forms.

51. ——— **Fungi injurious to crops.** Tenth Annual Report New Jersey Ag. Exp. Sta., 1889; published 1890, pp. 231–237. Notices prevalence of and remedies for potato-rot, grape-rot, cranberry gall fungus (*Synchytrium vaccini*, Thomas), cranberry scald, cucumber mildew (*Peronospora cubensis*, B. & C.), sweet-potato rots. The decay of market fruits. *Phyllosticta Halstedii*, Ell., on Lilac, (*Syringa vulgaris*, L.), mentioned as new.

52. ——— **Fungi injurious to horticulture.** Proc. N. J. State Hort. Soc., 15th Ann. Meeting, Dec. 18–19, 1889, published in 1890. Diseases of the following plants are briefly mentioned, with a possible remedy: Apple, pear, quince, peach, plum, cherry, grape, blackberry, raspberry, gooseberry, currant, strawberry, cranberry, Irish potato, sweet potato, egg-plant, tomato, watermelon, squash, cucumber, cabbage, lettuce, onion, carrot, celery, parsnip, beet, salsify, bean, pea, rose, violet, mignonette, and carnation.

53. ——— **Rusts, smuts, ergots, and rots. Some of the diseases that seriously affect field crops, vegetables, and fruits. Remedies that have proved successful.** Address before N. J State Board of Ag., Jan. 31, 1889 (May 26, 1890), Pamph. 8vo., pp. 21. Popular exposition with lists of fungi injurious to New Jersey farm crops, and illustrative plates of *Phytophthora infestans*, DBy., *Claviceps purpurea*, Tul., *Puccinia*, sp., *Tilletia* sp., and *Ustilago* sp.

54. ——— **A new white smut.** Bull. Torrey Botanical Club, April, 1890, Vol. XVII, No. 4, p. 95. Describes *Entyloma Ellisii*, n. s., as infesting the cultivated spinach, *Spinacea oleracea*. Notes *E. linariæ* forma *Veronicæ*, nov. forma, on *Veronica peregrina*, differing sufficiently from that on *Linaria vulgaris* to warrant name. Gives list of *Entylomata* with orders of host plants, showing *Spinacea* to introduce a new host order.

55. HARKNESS, H. W. **Curled leaf.** Zoë, San Francisco, Cal., Vol. I, No. 1, March. 1890, pp. 87–88. Remarks on probable identity of disease of leaves of *Æsculus Californica,* with *Ascomyces deformans*, Berk.

56. ——— **The nomenclature of fungi.** Zoë, San Francisco, Cal., Vol. I, No. 2, April, 1890, pp. 49–50. Remarks upon the probable identity of numerous different species described on nearly related hosts, noticing the excellent work of Dr. Farlow's Host Index, and criticising sharply the practice of species-making upon insufficient bases.

57. HARRIS, J. S. **Grape diseases.** Ann. Rep. Minn. State Hort. Soc. for 1889, Vol. XVII, pp. 284–287. Notices *Peronospora viticola,* B. & C., black-rot, white-rot, and bitter-rot; remarks on seriousness of last; gives remedies, referring to Dept. of Agr., Sect. of Veg. Path., Bull. 5.

58. HOLLADAY, A. L **Treatment of grape diseases.** Bull. 11, Sect. Veg. Path., U. S. Dep., Agr., p. 70. *Læstadia Bidwellii,* (Ellis) V. & R., and *Peronospora viticola,* B. & C., treated successfully with copper compounds.

59. HOWELL, A.M. **Report for 1889 in treating diseases of the grape and tomato** (with plates VII and VIII). Bull. 11, Sect. Veg. Path, U. S. Dept. Agr., p. 49. Describes at length course of treatment with Bordeaux mixture for *Læstadia Bidwellii,* (Ellis) V. & R.; and Bordeaux and ammoniacal copper carbonate solutions for tomato-rot (*Macrosporium* sp.).

60. JAEGER, HERMANN. **Treatment of grape diseases.** Bull. 11, Sect. Veg. Path., U. S. Dept. Agr., p. 65. Reports successful treatment of *Coniothyrium diplodiella,* (Speg.) Sacc. *Læstadia Bidwellii,* (Ellis) V. & R. and *Peronospora viticola,* B. & C. in Missouri, with note on presence of black-rot on wild species of *Vitis.*

61. JENNINGS, H. S. **Some parasitic fungi of Texas.** Bull. 9, Texas Agr. Expt. Sta., May, 1890, College Station, Texas. A list with notes on injuriousness. Several provisional new species given without descriptions. *Cercospora sp.* n. s., on *Begonia; Colletotrichium bromi,* n. s., on *Bromus unioloides; Diorchidium boutelouæ* on *Bouteloua racemosa; Ravenelia Texanus,* Ell. & Galw., on *Desmanthus* or *Cassia; Tilletia rugispora,* Ell. & Galw., on *Paspalum plicatulum; Ustilago apiculata,* Ell. & Galw., on *Andropogon saccharoides.*

62. KELLERMAN, W. A. **The hackberry** (with plate). Industrialist, Manhattan, Kans., Vol. XV, No. 26, March 1, 1890, p. 109. Notices disease of hackberry "knot" caused by *Sphærotheca phytoptophila,* Kell. & Swing., and *Phytoptus,* sp., gives distribution.

63. ——— **Prevention of smut.** Industrialist, Manhattan, Kans., Vol. XV, No. 25, February 22, 1890, p. 101. Reports on letter from J. L. Jensen regarding augmentation of crop by hot-water treatment, and method of using said treatment.

64. LATHAM, A. W. **Diseases of the grape-vine in Minnesota.** Ann. Rep. Hort. Soc. Minn. for 1889, Vol. XVII, p. 287. Notices "Greely rot," powdery mildew and downy mildew. Remarks latter to be the only serious disease in the section. Refers to work of Dept. of Agr. on the subject.

65. LOCKWOOD, SAMUEL. **Fungi affecting fishes. An aquarium study. First paper,** *Saprolegnia,* read March 7, 1890 (with plates 22–23). Journal New York Microscopical Society, Vol. VI, No. 3, July, 1890, pp. 67–78. Notices *Saprolegnia ferax* as attacking black sun-fish, spotted sun-fish and a species of pirate perch, in the aquarium. Twenty-four individuals succumbed to attack of fungus in six weeks. Describes and figures fungus, giving life history including formation of oospore; mentions *Dictyuchus* as found in connection with *S. ferax.* Thinks application of carbolic acid impracticable.

66. ——— **Fungi affecting fishes. An aquarium study. Second paper,** *Devœa,* read March 21, 1890 (with plate 24) *Ibid.,* pp. 79–85. Gives description of *Devœa infundibilis,* n. s. attacking and destroying in an aquarium six specimens of *Hippocampus heptagonus,* Rafin., giving abundant figures of fungus, with mode of growth.

67. LONSDALE, EDWIN. **Damping off.** American Garden, Vol. XI., No. 6; June, 1890, p. 348. Mentions greenhouse methods of treatment.

68. MASSEY, W. F. **Damping off.** American Garden, Vol. XI, No. VI, June 1890, p. 347. Ventures the opinion that the disease is due to the combined action of algæ and fungi.

69. MAYNARD, S. T. **Some observations on peach-yellows** (with figures). Bull, No. 8, Mass. Hatch Expt. Sta., April, 1890, pp. 6–12. Discusses symptoms of disease; its relation to food supply, injury by cold, borers, and accident; recommends destruction of all diseased trees.

70. ——— **Damping off.** American Garden, Vol. XI, No. 6, June, 1890, p. 347. Refers diseases to a fungus and recommends course of treatment.

71. MCBRIDE, T. H. **The saprophytic fungi of eastern Iowa** (with plates IV and V), Bull. Laboratory of Nat. Hist. of State University of Iowa, Iowa City, Vol. I, Nos. 3–4, June, 1890, pp. 181–195. Continues a descriptive list, with notes on distribution and microscopical characters, begun in Vol. I, No. 1, pp. 30–44. Noticing four species of the series *Hyporhordii*, eight of *Dermini*, ten of *Pratelli*, four of *Coprinarii*, and six species of *Coprinus*. Figures in part *Agaricus campester*, *A. sapidus*, *Russula* sp. *Polyporus lacteus*, *Morchella esculenta* and *Lycoperdon cyathiforme*.

72. ——— **Common species of edible fungi.** *Ibid.*, p. 196. Describes three species, *Morchella esculenta*, Linn., *Agaricus campestris*, L., and *Lycoperdon cyathiforme*, Bosc., as fit for table use.

73. MCCLUER, G. W. **The blight of the sycamore.** Garden and Forest, July 21, 1890, Vol. III. No. 123, p. 325. Notices *Glœosporium nervisequum*, (Fckl.) Sacc., as destructive to Sycamore trees at Champaign, Ill., for twenty years; also as found in northern and western Illinois, and in fact throughout the State.

74. MEEHAN, THOMAS. **Damping off.** American Garden, Vol. XI, No. VI, June 1890, p. 347. Refers diseases to a fungus, gives possible remedies.

75. MORGAN, A. P. **North American fungi.** Journ. Cincinnati Society of Natural History, Vol. XII, No. 4, January, 1890, p. 163. Third paper. Papers 1 and 2, found in Vol. XI, p. 149, and XII, p. 22 respectively. The *Gastromycetes*, read by title, February 4, 1890, (with Plate XVI).

76. ——— **Mycological observations I.** Bot. Gaz. Vol. XV., No. 4, April 19, 1890, p. 84. Mentions habitats and peculiarities of *Schizophyllum*, *Menispora*, *Arthrosporium*, *Bactridium*, *Nœmatelia nucleata*, Schw., *Stereum albobadium*, Schw., *Dacrymyces deliquescens*, Bull.

77. PAMMEL, L. H. **Some fungous diseases of fruit-trees in Iowa.** Abstract from Proceedings of the Iowa Academy of Sciences, 1887-'89. March 10, 1890. Mentions *Entomosporium maculatum*, Lév., as defoliating all young pear-trees with the exception of Chinese variety. Notes its presence on species of *Pyrus*, *Cydonia*, *Mespilus*, and *Cotoneaster*.

78. ——— **Diseases of forage plants.** Proceedings 16th Ann. Meeting Iowa Improved Stock-Breeders Association, pp. 138–141. *Puccinia graminis*, *P. rubigo-vera*, *Ustilago maydis*, *Tilletia striæformis*, *Claviceps purpurea* are noticed.

79. ——— **Beggiatoa alba and the dying of fish in Iowa.** Proc. Iowa Acad. Sci., 1887–'89, March 10, 1890. Notices presence of the putrefactive bacterium in waters of State in connection with dead fish.

80. ——— **A cherry disease.** *Ibid.* Treats of leaf disease caused by *Cylindrosporium padi*, Karst. Discusses synonomy, and refers *Septoria cerasina*, Pk., and *S. pruni*, Ellis, to *C. padi*, Karst. Iowa specimens were found by Mr. Ellis to agree with Karsten's species.

81. ——— **Cotton-root rot.** Second Annual Report Tex. Ag. Ex. Sta., College Station, Tex., pp. 61–85 (with Plates I–V, figuring *Ozonium auricomum*, Lk., and *Verticillium*). Gives theories and general character of the disease, plants affected by the cotton fungus (*O. zonium auricomum*, Lk.); the fungus on forest and

81. PAMMEL, L. H.—Continued.
apple trees; weeds affected; botanical characters; other fungi on the roots of cotton and sweet potato; the character of the lint of diseased cotton; the seed of diseased cotton; treatment, use of fertilizers and manure; rotation of crops; how and what plants to be used in rotation; treatment of forest and apple trees; also a list of references to articles on the subject.

82. ——— **New lima-bean mildew.** The Orange Judd Farmer, May 10, 1890. Gives popular description of *Phytophthora phaseoli*, Thax.

83. ——— **Onion smut.** Orange Judd Farmer, April 26, 1890. Popular review of report by Roland Thaxter in Annual Report Conn. Ag. Ex. Sta., 1880. *See* 10, I.

84. ——— **Smuts, wheat and oat.** Orange Judd Farmer, March 29, 1890. Popular exposition.

85. PEARSON, A. W. **Notes on strawberry culture.** Garden and Forest, March 19, 1890, Vol. III, No. 108, p. 141. Notices *Sphærella fragariæ*, Sacc., and recommends winter and spring liming. Sodium hyposulphite and potassium sulphide are thought also effective in treatment. Mentions burning with sulphuric acid as effective.

86. ——— **Report of experiments made in 1889 in treatment of fungous diseases of plants.** Bull. 11, Sect. Veg. Path., p. 41. Grape maladies, apple leaf-rust, pear leaf-blight (with Plates V, VI), quince diseases, melon blight, tomato blight, potato blight, strawberry leaf-blight, are treated of and the results of field experiments with fungicides given.

87. ——— **The use of fungicides in the prevention and cure of fungous diseases of plants.** Fifteenth Proceedings N. J. State Hort. Soc., Dec. 18-19, 1890, pp. 163–175. Popular address, giving results of original experiments with numerous diseases of grape, apple, pear, quince, and potato.

88. SCRIBNER, F. L. **Dotted or speckled anthracnose of the vine** (with fig.) Orchard and Garden, April, 1890, Vol. XII, No. 4, p. 82. Discusses disease, external characters, microscopical characters, quoting Viala's opinion that *Anthracnose macula* and *Anthracnose ponctuee* are caused by the same fungus. A wash of 50 per cent. solution of iron sulphate is recommended.

89. ——— **Plum-rot, or the monilia of fruit** (with figs.) Orchard and Garden, May, 1890, Vol. XII, No. 5, p. 103. Notices *Monilia fructigena*, with brief life history, figuring same. Quotes Erwin F. Smith, JOURN. OF MYCOL. 5, III, and discusses treatment with copper carbonate.

90. ——— **Apple scab and its treatment** (with figs.) Orchard and Garden, Vol. XII No. 6, June, 1890, p. 113. Gives distribution and destructiveness, with life history and methods of treatment, of fungus, quoting from Prof. Goff's report, Wis. Ag. Expt. Sta., 1889.

91. ——— **The smut of onions** (with figs.) Orchard and Garden, Vol. XII, No. 6, June, 1890, p. 113. Reviews at length work of Roland Thaxter in Ann. Rep. Conn. Ag. Expt. Sta. for 1889, giving figures redrawn. *See* 10, I.

92. ——— **Apple rust and cedar apples** (with figures taken from Ann. Rep. Sect. Veg. Path. 1888). Orchard and Garden, July, 1890, Vol. XII, No. 7, p. 134. Notices *Rœstelia pirata*, Thax., and *Gymnosporangium macropus*, Link., giving connection and life history, with recommendation to remove cedars from vicinity of orchards, plant resistant varieties of apples, and spray with the Bordeaux mixture.

93. ——— **Treatment of certain fungous diseases of plants.** Special Bulletin, Tenn. Ag. Expt. Sta., May 10, 1890. Gives results of usual methods of treatment for black rot of grapes, apple scab, downy mildew of the vine, brown-rot of grapes; powdery mildew of the grape-vine, gooseberry, rose, and apple; leaf brownness of pear and quince, potato rot, smut of oats and wheat, quoting from Kans. Expt. Sta. Bull. 8, p. 95.

94. ——— **Report on the extent, severity, and treatment of black-rot in northern Ohio in 1889.** Bull. 11, Sect. Veg. Path., U. S. Dept. Ag. Notes diminished parasiticism of *Læstadia Bidwellii*, (Ellis) V. & R., and destructive nature of *Peronospora viticola*, B. & C. in this region.

95. SECTION OF VEGETABLE PATHOLOGY. **Fungoid diseases.** Ann. Rep. State Board of Hort. of California for 1889. Issued 1890. Verbatim extracts from the reports of the section for 1887–'88, treating of *Entomosporium maculatum*, Lév., *Puccinia pruni*, Pers., *Podosphæra oxyacanthæ*, D. C., *Phragmidium mucronatum*, Wint., *Actinonema rosæ*, Lib., *Sphærella fragariæ*, Sacc.

96. SEYMOUR, A. B. **A race of flowerless plants, I.** Fungi—What they are and how they live (with figures). American Garden, February, 1890, Vol. XI, No. II, p. 79. Gives general outline of saprophytic and parasitic fungi, distinguishing the two, with suggestion as to time to apply remedies; figures *Uredo* stage of *Puccinia;* section of *Hymenomycetes* and others.

97. ——— **A race of flowerless plants, II.** The metamorphoses of Fungi—How different forms change into each other (with plate). American Garden, March, 1890, Vol. XI, No. III, p. 135. Notices apple rust (*Ræstelia*) (fig.), Cedar balls (*Gymnosporangium macropus*, Link.) (fig.), wheat rust (fig.) (*Puccinia graminis*, Pers., *P. Rubigo vera* (DC.) Wint., and *P. coronata*, Corda), Black rot (fig.). Refers to system of terminology used by botanists.

98. ——— **A race of flowerless plants, III.** Yeast and Bacteria—Putrefaction and Fermentation—Pear blight, (with figures). American Garden, Vol. XI, No. IV, p. 215, April, 1890. Notices discovery of bacterial diseases in plants by Burrill, with figures of pear blight bacteria and sections of diseased and healthy pear bark.

99. ——— **A race of flowerless plants, IV.** How fungi are dispersed, with hints for the cultivator (with figures after DeBary, Pringsheim, Hine and Brefeld). American Garden, Vol. XI, No. V, May, 1890, pp. 276–278. Notices methods of spore dispersion in *Discomycetes*, *Pilobolus*, *Saprolegnia*, *Phallus*, *Puccinia*, *Claviceps*, *Ustilago*, and hints at general means of preventing spread of diseases.

100. ——— **A race of flowerless plants, V.** How fungi injure plants (with figures.) American Garden, Vol. XI, No. VI, June, 1890, p. 353. Mentions spot diseases of currant leaves; spot disease of mignonette leaves; ergot, pear scab, plum pockets, cedar apples, and corn smut.

101. ——— **Damping off** (with figures). American Garden, Vol. XI, No. VI, June, 1890, p 349. Refers the disease to *Phytophthora omnivora*, DBy. (or *Pythium omnivora*) and *Phthium DeBaryanum*, Hesse. Thinks the latter most likely the cause of the trouble in America.

102. ——— **Notes on corn smut—a warning.** Cult. and Count. Gent., April 24, 1890, Vol. LV, No. 1943, p. 323. Describes life history of smut, and accounts for increase from year to year by reference to discoveries of Brefeld.

103. SNOW, F. H. **Experiments for the artificial dissemination of a contagious disease among chinch-bugs.** Proceedings nineteenth annual meeting Kansas State Board of Agriculture, pp. 142–144; also transactions Kansas Academy of Science, Vol. XII, Part I, for 1889 (1890), pp. 34–37. Notices *Entomophthora* disease of chinch-bug.

104. TAFT, L. R. **Experiments with remedies for the apple scab** (with plates II, III, and IV). Bull. 11, Sect. Vegt. Path., U. S. Dept. Ag., p. 30. Reports on experiment with twenty trees for disease of *Fusicladium dendriticum*, Fckl., using potassium sulphide, sodium hyposulphite, Bean's sulphur solution, ammoniacal solution of copper carbonate, modified eau celeste. Decides eau celeste and ammoniacal solution most efficient.

105. THAXTER, ROLAND. **Fungicides.** Bull. No. 102, Conn. Ag. Expt. Sta., March, 1890. Formulæ, with new spraying contrivance figured.

106. WEED, C. M. **A season's work among the enemies of the horticulturist** (with plates). Journ. Columbus Hort. Soc., Vol. IV, No. 4, December, 1889, pp. 94–106; extracted, February, 1890. Notices black rot of grape, quince leaf spot (*Morthiera mespili*, Sacc.), apple scab, brown rot of stone fruits (*Monilia fructigena*, Pers.), potato rot. Figures fruit rot and apple injured (?) by Bordeaux mixture.

107. ——— **Fungous diseases of plants and their remedies.** Bull. Ohio Agr. Expt. Sta., second series, Vol. III, No. 4, April, 1890. Notices or defines briefly potato blight or rot, apple scab (quoting from Report U. S. Dept. Ag., for 1889), pear leaf blight, powdery mildew of apple and cherry, and plum fruit rot.

108. ——— **The brown rot of the stone fruits** (with figures). The American Garden, Vol. XI, No. III, March, 1890, p. 165. Mentions attacks of *Monilia* on plums, cherries, and peaches with efforts made at Ohio Expt. Sta. to check same by use of copper compounds.

109. ——— **The potato blight.** Am. Agriculturist, July, 1890, p. 360, Vol. XLIX, No. 7. Discusses use of Bordeaux mixture and ammoniacal solution in treatment for *Phytophthora infestans*, DBy.

110. WATSON, B. M., jr. **Damping off.** American Garden, Vol. XI, No. 6, June, 1890, p. 348. Refers disease to *Pythium omnivora*, and gives preventive measures to be taken to avoid the trouble. Pricking off into fresh soil considered as the best remedy.

111. WOOLVERTON, L. **Treatment of apple scab.** Canada Horticulturist, June, 1890, p. 165. Sums up work done with *Fusicladium dendriticum*, Fckl., with special notice of JOURN. OF MYCOL., Vol. V, No. 1, p. 210.

112. ——— **The strawberry leaf blight** (with figures from Bull. XIV Cornell Univ.). Can. Hort., April, 1890, p. 109. Notices *Sphærella fragariæ*, Sacc., with review of Professor Dudley's article in Bull. XIV, Cornell Univ.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF VEGETABLE PATHOLOGY.

Vol. VI. No. 3.

THE JOURNAL OF MYCOLOGY:

DEVOTED ESPECIALLY TO THE STUDY OF FUNGI IN THEIR RELATION TO PLANT DISEASES.

EDITED BY

THE CHIEF OF DIVISION AND HIS ASSISTANTS.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1890.

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VOLUME VI, No. 3. } JOURNAL OF MYCOLOGY. { ISSUED January 6, 1891.

EDITED BY

THE CHIEF OF DIVISION AND HIS ASSISTANTS.

CHIEF,
B. T. GALLOWAY.

ASSISTANTS,
EFFIE A. SOUTHWORTH. DAVID G. FAIRCHILD. ERWIN F. SMITH.

EXPERIMENTS IN THE TREATMENT OF PLANT DISEASES.

By B. T. GALLOWAY and D. G. FAIRCHILD.

PART I.

TREATMENT OF BLACK ROT OF GRAPES.

The present season a series of experiments was made by the writers with a view of determining the value of certain lines of treatment for several destructive plant diseases. The results of this work we propose to set forth in two or three papers which we hope to get into the hands of fruit growers, and others directly interested, before spring. The present paper relates to an experiment made in the treatment of black rot of the grape, at Vienna, Va., 12 miles southwest of Washington.

The vineyard is the property of Capt. J. O. Berry and consists of 1,000 Concord vines sixteen years old trained to stakes 8 feet high. The vines had never been treated for rot, in fact they had been practically abandoned for the past five years on account of this disease. This, together with the fact that there had been little done in the way of pruning or soil cultivation, offered the very best means of thoroughly testing the value of the fungicides.

In the experiments an endeavor was made to throw some light on the following questions:

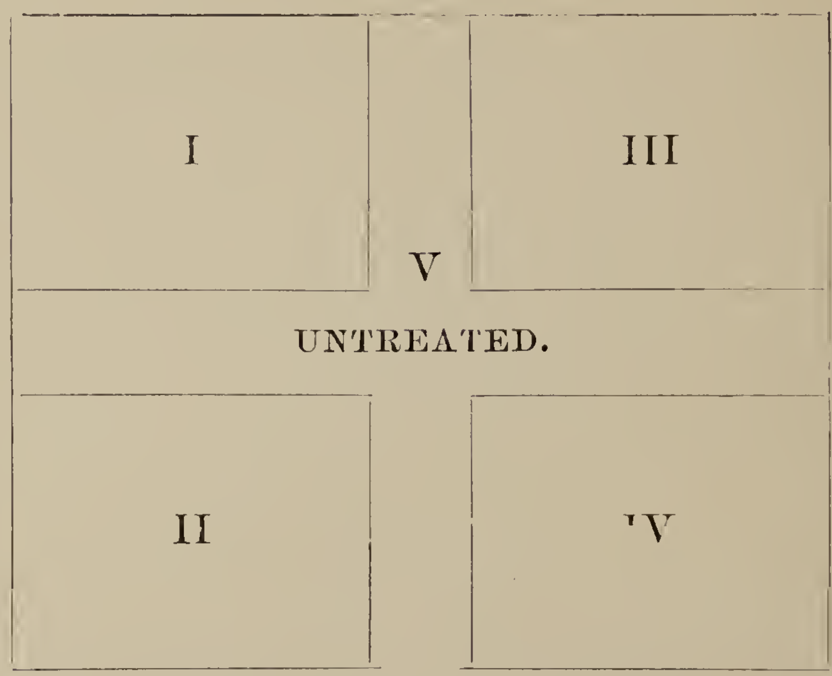
I. The best means of applying the preparations.

II. The relative value of the Bordeaux mixture, ammoniacal copper carbonate solution, copper carbonate in suspension, and a mixed treatment consisting of three applications of the Bordeaux mixture followed by five of the ammoniacal solution.

III. The actual cost of each treatment.

IV. The amount of copper found at the harvest on fruit treated with Bordeaux mixture.

The vineyard was divided into five plats as shown in the accompanying diagram.



Plat I, consisting of 203 vines, was treated with Bordeaux mixture, formula *b*.

Plat II, of 221 vines, treated with ammoniacal solution of copper carbonate.

Plat III, 167 vines, treated with copper carbonate in suspension, 3 ounces to 22 gallons of water.

Plat IV, 183 vines, treated three times with Bordeaux mixture, followed by five applications of the ammoniacal copper carbonate solution.

Plat V, 179 vines, no treatment.

All of the plats received eight sprayings, the first on May 1, and the rest, excepting the last, at intervals of fifteen days. The last spraying, on account of dry weather, was prolonged to 20 days.

Plats I to IV, inclusive, were of practically the same area, but owing to removals of dead vines an actual count revealed the number for each division to be as given above.

Of the various plats it may be said that early in the work it was observed that Plat I was made up of superior, and Plat III of inferior vines. Hence it was not expected that there would be entire uniformity in the yield of the various divisions even if the treatment for all had been the same. The pruning for 1890 was done in March, and at the same time the weeds, grass, and old berries were plowed under. This work was rather hastily done, as could be seen from the quantities of débris lying about under the vines even as late as the middle of April.

Applying the Remedies.—In this work three spraying machines were tried, namely, the Eureka, manufactured by Adam Weaber, of Vineland, N. J.; the Japy, made for us by the Columbia Brass Works, of Washington, D. C., and a Little Giant machine manufactured by the

Nixon Nozzle and Machine Company, of Dayton, Ohio. The Eureka and Japy are knapsack pumps, each holding about 4 gallons. The Little Giant is a cart machine holding 40 gallons and is designed to be drawn by hand. After a careful test of all the machines the Little Giant was selected as the one best adapted to our wants. It was provided with 16 feet of hose, and owing to the manner in which the vines were trained this enabled us to treat 4 rows at a time. There is no doubt that the knapsack pumps are less wasteful than the Nixon machine, and when arrangements can be made for properly filling them without loss of time they will doubtless be found as effectual and economical for reasonably small vineyards as any pumps now in use. Of course, for large vineyards one should have a machine capable of utilizing horse power. Throughout the experiments we used the Improved Vermorel nozzle and lance, which has already been figured and described in the published reports of this Division.*

Relative value of the treatments.—During the entire work an endeavor was made to have the conditions for all the plats as nearly alike as possible, in order that at the harvest the percentage showing the relative value of the treatments might be obtained. For reasons already given the total yields for the various plats were not to be relied upon, hence the following plan was adopted for determining the effects of the sprayings.

On July 30, when it was evident that no further changes due to the disease would occur in the fruit, the different plats were carefully examined and every bunch counted. As the counting proceeded the bunches were divided into two classes, namely, diseased and healthy. Every bunch showing five or more diseased berries was classed as diseased, while all bunches having less than five diseased berries were counted healthy. Assuming that all of the diseased bunches were *lost*, we were able by a single calculation to get the percentage of fruit saved for each plat. A comparison of these percentages shows the value of the various treatments. The only source of error in such a calculation is that some of the treated bunches might have become diseased and dropped from the vines before the count was made. This would have been serious had it not been carefully noted, at frequent intervals during the entire work, that the treated sections scarcely lost a berry.

Below are given the results of the count as above described:

PLAT I.

Treated with Bordeaux mixture.

Number of vines		203
Total number of bunches		2,289
Number of diseased bunches		19
Number of healthy bunches		2,270
Per cent. saved	99.2	

* Journal of Mycology, vol. 6, No. ii, p. 57. Circular No. 8.

Plat II.

Treated with the ammoniacal copper carbonate solution.

Number of vines		221
Total number of bunches		3,135
Number of diseased bunches		80
Number of healthy bunches		3,055
Per cent. saved	97.5	

Plat III.

Treated with copper carbonate in suspension.

Number of vines		167
Total number of bunches		708
Number of diseased bunches		45
Number of healthy bunches		663
Per cent. saved	93.64	

Plat IV.

Treated three times with the Bordeaux mixture, followed by five applications of the ammoniacal copper carbonate solution.

Number of vines		186
Total number of bunches		1,866
Number of diseased bunches		51
Number of healthy bunches		1,815
Per cent. saved	97.27	

Plat V.

No treatment.

In this plat, consisting of 179 vines, every bunch was diseased, so that according to the classification adopted the loss was total. By the 21st of July the majority of the bunches had fallen. On the 30th, however, it was thought best to count all bunches which had two or more healthy berries upon them. As a result of this count it was found that the yield was 170 bunches, none of which were fit for market.

Bringing together now the several percentages of fruit saved we have for—

Bordeaux mixture	99.20
Ammoniacal copper carbonate solution	97.50
Copper carbonate in suspension	93.64
Bordeaux mixture and ammoniacal copper carbonate solution	97.27
Untreated	00.00

Cost of the various treatments.—The total cost of treating each plat, estimating the labor at 15 cents an hour, was as follows:

Plat I.—203 *vines.*

Bordeaux mixture.

210 gallons of mixture	$4.41
14 hours labor	2.10
Total	6.51
	Cents.
Cost per vine	3.2
Cost per pound of fruit	1.2

PLAT II.—221 *vines.*

Ammoniacal copper carbonate solution.

196 gallons of solution	$1.47
12½ hours labor	1.85
Total	3.32
	Cents.
Cost per vine	1.50
Cost per pound of fruit	.77

PLAT III.—167 *vines.*

Copper carbonate in suspension.

147 gallons of solution	$0.75
10 hours labor	1.50
Total	2.25
	Cents.
Cost per vine	1.35
Cost per pound of fruit	2.08

PLAT IV.—186 *vines.*

Bordeaux mixture and ammoniacal solution.

302 gallons of mixture and solution	$3.84
10 hours labor	1.50
Total	5.34
	Cents.
Cost per vine	2.87
Cost per pound of fruit	1.64

The total yield in pounds of the various plats was approximately as follows:

	Pounds.
Plat I	540
Plat II	432
Plat III	108
Plat IV	324
Total	1,404

The fruit was sold on the vines for 6 cents per pound, making the revenue from each plat as follows:

Plat I	$32.40
Plat II	25.92
Plat III	6.48
Plat IV	19.44
Total	84.24

It will be seen by comparing these figures with those giving the total cost of the various treatments, that for Plat I, treated with Bordeaux mixture there was saved $32.40 worth of fruit at an expenditure of $6.51, leaving a profit of $25.89, or 397 per cent.

For Plat II, treated with ammoniacal copper carbonate solution, there was saved $25.92 worth of fruit at a cost of $4.32, leaving a profit of $21.60, or 500 per cent.

For Plat III, treated with copper carbonate in suspension, the value of the fruit saved was $6.48, the cost of treatment $2.25, leaving a profit of $4.23, or 188 per cent.

For Plat IV, treated with Bordeaux mixture and ammoniacal solution, the value of the fruit saved was $19.44, the expense of treatment $3.34, leaving a profit of $16.10, or 482 per cent. A further study of these figures, together with those already given, brings out a number of interesting points, chief of which may be mentioned the following:

I. That while the amount of fruit saved by the Bordeaux mixture was greater than that by the ammoniacal solution the latter preparation is, after all, the cheapest. In other words, there was more profit in using the ammoniacal solution than the Bordeaux mixture.

II. A mixed treatment consisting of Bordeaux mixture and ammoniacal solution is more profitable than a treatment of Bordeaux mixture alone, but not as profitable as the ammoniacal solution alone.

III. There is nothing whatever to be gained by treating with the copper carbonate in suspension when the ammonical solution is at hand.

COPPER ON THE FRUIT AT THE TIME OF HARVEST.

The question has often been asked whether there is any danger to be apprehended from eating grapes which have been sprayed with the Bordeaux mixture and other copper solutions.

To obtain some information in regard to this matter representative bunches were taken from Plat I, which was sprayed eight times with Bordeaux mixture.

The last spraying was made on these vines July 30, and between that date and August 28, the day of harvest, only a few slight rains had fallen. The fruit showed the mixture plainly, more pronouncedly in fact than any treated grapes seen in the market. One kilogram of the clusters ($2\frac{1}{5}$ pounds), including the stems, which appeared to have the greater part of the copper, was weighed out, dried, and analyzed.* As a result of this analysis 1 kilogram of the fruit yielded .005 grammes (.077 grain) of metallic copper. On this basis every pound of grapes treated with Bordeaux mixture contained $\frac{35}{1000}$ of a grain of copper. An adult can take from 8 to 12 grains of this salt without fear of serious results, and to get this amount from sprayed grapes he would have to eat from a ton to a ton and a half of fruit.

According to M. Fallot† the minimum amount of copper introduced into the human system daily through the food is 1 milligram, a trifle less

* The charring of the clusters was performed at the Department, but the analysis was kindly made by Dr. R. C. Kedzie, Mich. Ag. College.

† Progrés Agricole et Viticole, June 16, 1890. Bull. 11, Sect. Veg. Pathology, p. 100.

than one-half of that necessarily taken with each pound of grapes, stems and all, sprayed as profusely as those analyzed.

When it is considered that 203 vines received in one season's treatment only 57.25 pounds of copper, or $4\frac{1}{2}$ ounces per vine, the very inconsiderable amount which remains adherent to the berries is not to be wondered at. Although spraying after the middle of July with the Bordeaux mixture is to be avoided, it will be seen that there is no real danger arising therefrom, and when the ammoniacal solution is substituted for the last three sprayings, since it contains only $\frac{1}{32}$ as much copper, there can be no possible danger.

DISEASES OF THE GRAPE IN WESTERN NEW YORK.

Numerous complaints having been received from correspondents in various parts of western New York of a disease which was seriously injuring grape vines, it was decided to send some one into the field to investigate the matter. Accordingly, on October 18, Mr. D. G. Fairchild was directed to visit Lockport, N. Y., and such other points within the State as might be necessary, and to obtain such information and make such investigations as would enable him, if possible, to determine the cause of the trouble and suggest a remedy therefor. Below is Mr. Fairchild's report.

B. T. GALLOWAY,
Chief of Division.

WASHINGTON, D. C., *October* 25, 1890.

SIR: In accordance with your instructions, I left Washington on October 18, proceeding directly to Lockport, N. Y., where, through the kindness of the Niagara White Grape Company, I was enabled to obtain much valuable information relative to the new disease of the grape, which is generally referred to under the name of "blight" or "rust." After leaving Lockport several important grape-growing regions were visited, in all of which the new trouble was found more or less abundantly. I submit my report on the investigations made, and also add some notes on other vine diseases which came under my observation.

Respectfully,

D. G. FAIRCHILD,
Assistant.

The attacks of the disease seem to be confined to bearing vines three or more years from planting. So far as known, it has occurred, during the past season, only in the grape-growing districts of western New York, and is now present in Niagara, Wayne, Cayuga, Seneca, Steuben, and Ontario Counties. While it may be presumed that the same trouble exists in the intervening counties, and, perhaps, in other sections along the Great Lakes, it has not been definitely reported from these localities. This year the disease appeared simultaneously in the different districts soon after September 1, and in most of them for the first time, but in one locality, Ontario, Wayne County, it is reported to have appeared for the first time two years ago, when it did considerable damage. One vineyard was observed which was previously affected, and in this the area diseased this year did not appear to be entirely coincident with the portion worst affected two years ago.

CHARACTERS OF THE DISEASE.

Small irregular blotches of a dark color appear between the veins, these enlarge rapidly, darken to a dull purplish or reddish brown and coalesce so as to fill up the space between the veins which remain green or yellow. These changes occur so rapidly that the foliage seems to change color suddenly. The contrast between the green or light yellow veins and dark purplish brown of the intervening tissues gives a peculiar streaked appearance to the leaves. In the most serious cases they curl up, become dry and brittle, and finally drop from the vine, leaving it nearly bare.

The berries borne upon diseased vines, almost without exception, have a flat, insipid, and often intensely sour taste, due to the fact that they are only partially ripened. When the attack is severe the berries drop off, and the ground beneath a diseased vine is often seen to be covered with half ripe grapes. The berry is found to part from its pedicel taking with it the fibers which enter the interior of the pulp and are normally withdrawn from it when the berry is pulled off. After the crop has been harvested, also, the bunches are found to "shell" badly, ruining them for market.

The roots of diseased vines, when carefully examined, fail to show a healthy growth of young feeding rootlets. When the roots of healthy and unhealthy vines are compared, although as is to be expected late in the season (October 20–25) the fibrils have many of them dropped from all vines, the difference in favor of the healthy vines points quite plainly to the fact that root absorption has been stopped earlier where the disease is present. This early stoppage of the action of the rootlets may account for the peculiar coloring of the leaves and failure of the canes to mature their wood.

As will be seen from the following somewhat free translation from Pierre Viala's work (The Diseases of the Vine, p. 432) the malady corresponds in many respects to what this eminent viticulturist calls *Rougeot* and which he considers a mild form of the destructive *Apoplexie* which has been long noticed in France.

Grape leaves sometimes suddenly assume a red color, especially in midsummer at the heated periods when there are strong dry winds or when the temperature falls suddenly. The leaf tissues become leathery and fragile between the veins, and the color, which normally would be that of a dead autumn leaf, is a bright, almost rose red and at times a wine color, while the veins remain green or yellowish, later the color becomes dull and the leaves dry up.

The yellowish shoots dry up, beginning at their bases. But the vine is not diseased beyond recovery as is the case with Folletage. It puts out green branches in the course of the same year and in the following year the only evidence of the disease is a slight weakness of the vine.

G. Foëx, in his Complete Course of Viticulture,* thus describes under the same name a disease which he considers somewhat distinct from *Apoplexie* or *Folletage :*

Rougeot is a disease which resembles Folletage in the conditions which cause it as well as in its general effects. Like this, it attacks the vine while it is in full growth, at the first heated period, and prevails especially in deep and cold soils.

Thiebaut de Berneaud † says that it is produced during the summer after a cold rain, a storm which suddenly lowers the temperature, or even a fog, when these are succeeded by warm south winds.

M. Mares ‡ gives the following description :

"The leaves change, becoming like parchment, and lose their flexibility; the tissue between the nerves becomes red, while the nerves themselves remain green, giving the leaves of diseased vines quite a peculiar appearance; the berries shrivel, the canes remain yellow, and if the malady becomes more severe the leaves dry up entirely and the canes partially die—rotting from the extremity to the base. A vine is sometimes attacked only upon one side, which becomes brown, while the other parts remain green. * * * The vines diseased with rougeot do not die, as in the case of apoplexie, but are much injured, and their natural fertility is considerably diminished, only recovering after several years. Drainage appears to be, as in the case of apoplexie, the best means of diminishing the chances for the development of this malady."

While the above descriptions contain many conflicting statements it is reasonably certain that the malady seen by the various authors is the same and is probably of a like nature to the one in question. Viala in his *Mission Viticole en Amerique* mentions folletage, of which he considers rougeot a mild attack, as occurring in the Atlantic States, especially in the South.

A careful microscopic examination of all parts of the diseased vine has revealed absolutely nothing of the nature of a parasitic fungus which could in any way be connected with the malady. Leaves, canes,

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* Cours complet de Viticulture, par G. Foëx, Paris, 1888, p. 421.

† Nouv. Manuel complet du Vigneron français. Manuels Roret, p. 186, quoted by Foëx.

‡ Des Vignes dans le Midi de la France in le Livre de la Ferme, Paris, Masson, 1865, p. 173, quoted by Foëx.

and roots seem perfectly free from any form of parasitic plant or animal. However, as this examination was only made late in the season, the decision as to the presence of parasitic organisms can not be considered as final.

CAUSES.

On the other hand, circumstances in this case as with the disease in France point to a close relation between the diseased vines and the condition of the soil with regard to drainage. In general it may be said that the worst attacks of the disease occur upon cold, heavy soils containing a large percentage of clay and rich in nitrogenous matters. Of the nine vineyards visited, which were over three years old from planting, seven showed the disease badly, and of these five were not underdrained and the remaining two only partially so. In the two vineyards which were upon high, well drained land the trouble was present only in its mildest form, in fact the attack was so slight that the owners had not noticed it. In one vineyard two adjacent plots, one cultivated for years as the family garden, the other in the regular farm rotation, showed a most striking contrast. The garden plot, although situated nearer the base of the slope, showed no signs of the trouble, while the plot in regular rotation had most of its vines badly diseased. Notwithstanding these facts, however, in particular vineyards the appearance of diseased vines upon its most elevated portions showed the disease was not wholly confined to cold, deep soils.

So far as the investigation goes there seems to be no connection whatever between the fertilizers used and the trouble, diseased plants being found upon land unmanured, heavily manured, fertilized with phosphates, wood ashes, and bone dust. In all cases the soil, although not chemically examined, seemed to be rich in nitrogenous matters and was fertile in every sense. It seemed, however, to lack one element, lime, which had not been applied and was evidently not abundant.

SUGGESTIONS IN REGARD TO TREATMENT.

In cases where the soil is at all inclined to retain more moisture than necessary, thorough underdraining will probably be the surest means of preventing a second attack. Should the vines show no mature wood available for the next year the better plan will be to prune close to the ground and raise an entirely new growth. Where the attack has been slight and enough mature wood remains to grow new bearing canes another season, such severe treatment is not necessary.

In any case, the pruning should be postponed as late as possible in order to give the canes that are still green all possible opportunity to ripen. The diseased vines should not be allowed to bear heavily the coming season, as the necessary strain may favor a second attack of the disease. Further investigations are, of course, necessary to ascertain more definitely the immediate cause of all such maladies.

BLACK ROT.

The presence of this disease was noted in all the counties visited, but its attacks this season have evidently been slight as compared with its ravages farther south, only an occasional cluster being attacked. That the malady has gained a foothold throughout this section can not be doubted, but timely applications of the copper mixtures will, if early undertaken, prevent severe ravages in future seasons.

ANTHRACNOSE.

Found sparingly at Fair Haven, Lyons, and Romulus, where it had damaged the fruit principally, only an occasional cane being affected.

DOWNY MILDEW.

This disease appears to be one of the worst pests of the New York vineyardist, presenting itself in the form of gray rot or brown rot in most of the vineyards visited, but as far as seen doing only slight damage to the foliage.

POWDERY MILDEW.

Numerous cases of this fungus were seen in almost every vineyard examined, except those sprayed with some of the copper mixtures. The fruit where attacked becomes discolored, and accumulations of dust which can not be removed occur upon the diseased portions rendering the clusters unfit for market.

GRAPE GLŒOSPORIUM.

This disease,* to be described in another number, although a new one, should be carefully looked after. It was noted in every packing house visited, and although any of the copper remedies would doubtless check its ravages it is likely to prove a troublesome pest.

GRAPE CLADOSPORIUM.

Upon two vines of Clinton in Cayuga County the immature stage of a species of *Cladosporium* was noticed in connection with powdery mildew. The berries attacked assumed a dirty orange-yellow hue, became rough and unsightly, and were ruined for market purposes. It is hoped that the mature spores of this fungus may be found and the species identified, but as yet only the mycelial form has been seen forming a thick felt composed of much torulosed mycelium upon the epidermis of the berry.

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*Ann. Report, 1890.

ANTHRACNOSE OF COTTON.*

(Plate IV.)

By E. A. Southworth.

This disease, like others of the same name, is exceedingly destructive to the plants which it attacks and is caused by a fungus resembling the Glœosporiums. The presence of dark colored setæ among the spores and basidia separates it from the genus *Glœosporium* and makes it a *Colletotrichium*, but the general character of the fungus, so far as its effect on the host is concerned, is very similar to that of the Glœosporiums, well known as Anthracnose of the grape and raspberry. In the cotton fungus the setæ do not at first develop in any numbers, but become very numerous as the fungus grows older.

When the fungus was first brought to our notice, some immature specimens were sent to Mr. Ellis, who afterwards sent them to Mr. Cooke; both agreed that they were identical with *Glœosporium carpigenum*, Ck. & Hk., and the fungus was distributed in Ellis's North American Fungi under this name. Through the kindness of Professor Harkness I have recently been enabled to compare it with type specimens of *G. carpigenum*, and find it quite distinct from this fungus. *G. carpigenum* is a true *Glœosporium* with no setæ and the fruit borne in isolated pustules. The spores are also much smaller than those of the cotton fungus. These characters, as will be seen further on, separate the latter from *Glœosporium carpigenum* and the possession of setæ places it in the genus *Colletotrichium*. There seems to be no record of any specific name ever having been given it and I will call it *Colletotrichium gossypii*.†

EXTERNAL APPEARANCE AND EFFECTS ON THE BOLL.

According to Mr. Atkinson, who has observed the disease in the field, the fungus attacks all parts of the plant. It has been sent to us, however, only on the boll, and this description must therefore be limited.

So far as can be judged from specimens that have been picked from

* Since this article was prepared, Professor Atkinson read a paper on the same subject before the Association of American Agricultural Experiment Stations at Champaign, Ill. The work in both cases was entirely independent, except where I have cited Professor Atkinson's authority in regard to the parts of the host plant attacked.—E. A. S.

† *Colletotrichium gossypii*, n. s. On cultivated cotton, may occur on any part of the plant, especially injurious to bolls. Sori orbicular, dark colored, or covered with a pink powder. Acervuli erumpent, distinct only when young. Spores irregularly oblong, usually with a light spot in the center, often acute at one end, colorless singly, flesh-colored in mass, borne on short basidia or long setæ. Basidia colorless varying in length, at least longer than the mature spore, very rarely branched, borne on a stroma of varying thickness, 11–28 x 5μ. Setæ occurring singly or in tufts, more abundant in older specimens, dark brown at base, but nearly colorless at the apex, septate, often irregular in outline, straight or flexuose, rarely branching, often bearing spores. Mycelium septate, intra and intercellular, usually colorless, producing secondary dark colored spores, especially when it has simply the form of a germ tube. Stroma of varying thickness, often penetrating the plant tissues for some distance, becoming dark colored with age or where setæ are borne.

one to five days and sent through the mails, the external appearance and progress of the disease on the boll is as follows:

One or more dark colored spots make their appearance on the green capsule. These increase in size and usually become covered with a flesh-colored powder for a short time. This is likely to disappear later leaving a poorly defined spot from which a blackish discoloration, often showing little spots of the pink powder on its surface, extends over the boll. The black discoloration may reach a considerable extent before the spot becomes pink at all, and judging from the appearance of some of the bolls it would seem as if the black color sometimes appears independently, without the pink spots. The growth of the capsule ceases wherever the discoloration extends; this causes the segments to crack apart through the diseased areas, leaving the half-ripe cotton exposed to the rain and dew as well as to the attacks of numerous insects. The capsule itself loses its power of resisting moisture and often becomes water-soaked and covered by saprophytic fungi. The saprophytic fungi, as well as the fungus causing the disease, often penetrate the cotton mass itself and the exposed portion becomes covered with a pinkish powder or with the white filaments and fruit of the saprophytes. As might be expected under these untoward circumstances, the cotton, and often the seeds as well, decays very quickly, especially if wet weather follows and if the bolls are attacked when young. If, however, they do not become diseased until they are nearly ready to burst open, and the weather remains dry, they may not be materially injured.

BOTANICAL CHARACTERS.

The vegetative portion of the fungus is branching and septate (Fig. 6), usually colorless, but sometimes showing a little darkening of the walls, of varying diameter, but usually about 5 μ. The mycelium penetrates the cells, often showing a constriction where it passes through the walls, with a slight enlargement on one or both sides (Fig. 5.). Frequently a hypha runs along in contact with the wall for some way before it pushes through. The mycelium is exceedingly abundant in the tissues, and sometimes appears to nearly fill the cells. In consequence of its presence the cell contents become disorganized and the cell walls frequently collapse, especially near the surface, where a section through the diseased tissue shows no cavities remaining. The chlorophyll is at first resolved into bright green globular masses, but later all the green color disappears, leaving only a small quantity of disorganized brownish material in the cells.

Anywhere in its course the vegetative mycelium may send off branches which push out to the surface and bear spores at their free ends. A quantity of these are generally sent off close together and become so matted at the surface of the boll that a stroma is formed from which spring the ends of the spore-bearing branches or basidia. This stroma varies very much as regards quantity; it may be a scarcely perceptible layer, or it may extend for some distance above the surface and pene-

trate between the cells for three or more layers (Fig. 3), completely surrounding the discolored cell fragments that remain, probably because the fungus is not able to absorb them. In older specimens the fruit is not borne in distinct pustules, but the epidermis seems to be broken up into flakes and the basidia are borne uniformly or in tufts on the fruiting surface. In the course of from two days to a week after the first basidia and spores are formed the dark brown setæ may be formed among them. They grow out from somewhat enlarged darker cells in the stroma, and are bluntly rounded at first, but become more acute as they grow older. They are frequently enlarged or present other irregularities somewhere along their course, especially near the tip (Fig. 1 *a*). The bases are a very dark brown, but the tips are usually nearly colorless. Under some conditions, especially in a moist atmosphere, the setæ may bear spores at their tips. These spores seem to be somewhat smaller than those borne on the regular basidia, but in artificial cultures the two kinds are indistinguishable. At first the setæ are few, but they increase in number with the age of the fungus, and in some sections the conclusion that the basidia themselves are being transformed into setæ is almost irresistible. In older specimens the setæ appear in large tufts and sometimes branch. It is not infrequently the case that one seta arises from the lower end of another; a beginning of this may be seen in Fig. 1. The amount of stroma is also seen to increase with age, especially beneath the setæ, where it becomes very dark colored. In old specimens the setæ are borne considerably above the basidia, so that the latter line the cavities between them (Fig. 1). The tufts of setæ may even have the appearance of being pushed up and out of the way by the basidia and spores behind them.

The spores are oblong, and usually have a vacuole in the center. Viewed separately under the microscope they are colorless, but in masses they form a salmon-pink powder which gives the color to the spots as already described. They are successively abscised from colorless basidia, which vary greatly in length and may branch when kept excessively moist (Figs. 4–7). Usually the connection between the spore and the basidium becomes smaller until the spore is cut off; but there are cases where the spore falls from the end of the basidium when the septum separating them is half as wide as the basidium itself, which appears truncate after the spore has fallen. The setæ which have borne spores also often have a truncate appearance.

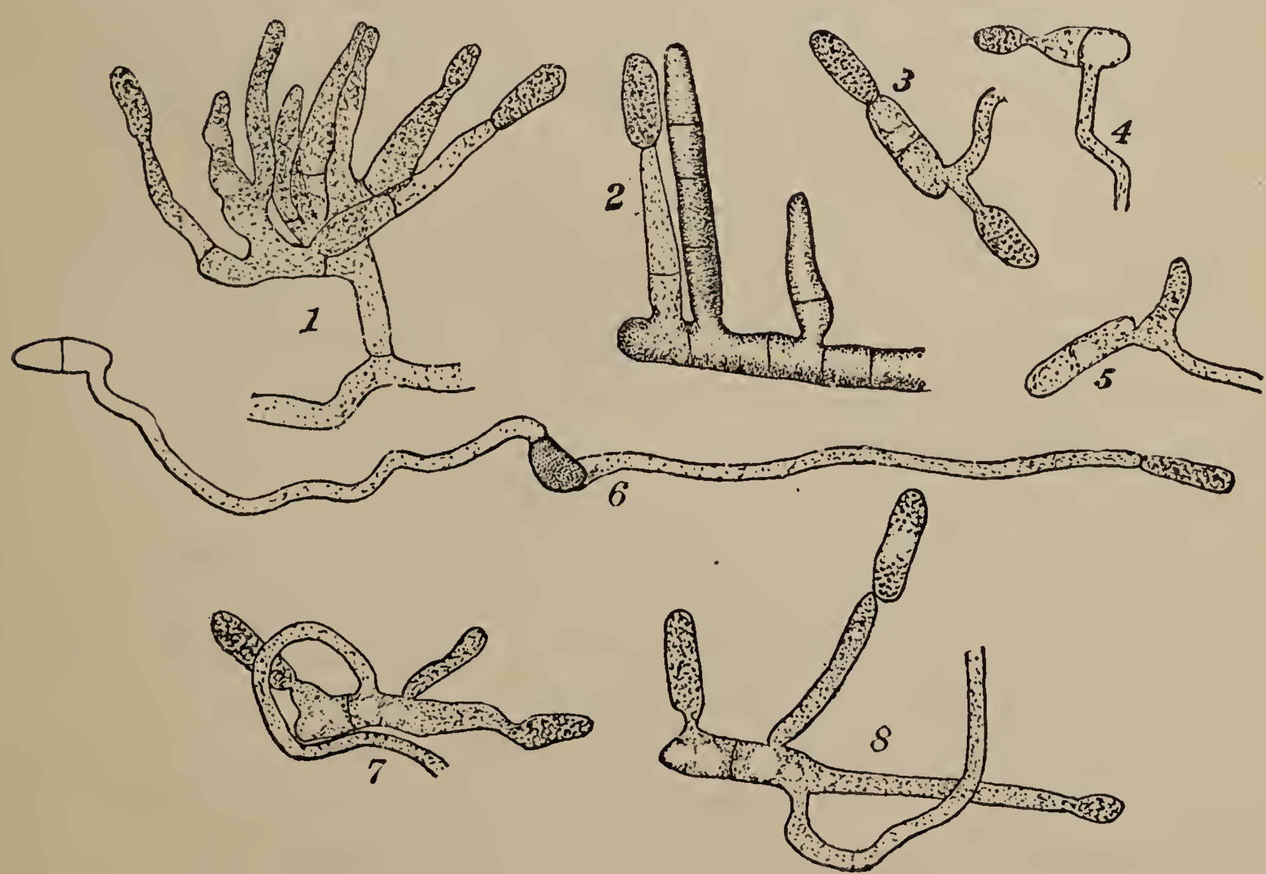
The fungus retains its vitality under very adverse circumstances. Some specimens of diseased bolls were allowed to lie in the heated air of the laboratory for a month or more. The pink spore powder was then entirely washed from the surface, a piece cut out and soaked, and placed under a bell glass. In three days the surface again showed small masses of pink spores that had been produced since the fungus was put under the bell glass.

An attempt was made to grow this fungus in a decoction of hollyhock agar-agar. This was only a partial success, for while spores and setæ

were produced the fungus was evidently in an unfavorable medium and was short-lived. However, some very important results were obtained.

In forty-three hours from the time of sowing, a distinct mycelium had been formed which bore numerous basidia at right angles to its branches and these were already producing spores (Fig. 7 b). Along with these spore-producing branches were others which differed from the basidia and ordinary mycelial branches in being devoid of visible granular contents, and on close inspection seemed to be a trifle darker colored and thicker walled. They sometimes had a septum near the base and were shaped like setæ. Twenty-four hours later there were well developed setæ on the same mycelium that bore the basidia and spores. As the mycelium grew older more setæ made their appearance; but in the moist environment in which it was necessary to keep the artificial substratum nearly all of them bore spores and were even more irregular in appearance than they are in nature.

After the setæ begin to form it is difficult to find basidia and setæ close together. The parts of the mycelium that bear setæ bear nothing else. Septa are often produced in the mycelium at each side of the bases of the setæ and the cell thus formed sometimes grows larger and darker colored than the remainder of the filament, while the threads which bear setæ are often coarser and darker colored throughout. This may explain the dark colored cells at the bases of the tufts of setæ as they occur in nature.



1. Tuft of basidia, with young spores rising from a single thread, showing mode of formation of fruiting surface.
2. Basidium and seta springing from the same mycelial thread.
3, 4, and 5. Spores twenty-four hours in water, showing spores produced by budding.
6. Germinating spore, with germ-tube and secondary spore, which in turn has sent out a germ-tube bearing a spore at the end.
7 and 8. Spores forty-eight hours in water.

Spores were also sown in a decoction of cotton bolls in agar-agar. In this the fungus grew more luxuriantly and rapidly, but was much slower in producing setæ, and when these were first discovered, nearly a week after they were sown, they were already bearing spores. For the first few days only colorless basidia could be found. When a spore was produced on this mycelium it was cut off from the end of the basidium and another formed on the same place, pushing the former one aside. This may occur until there is a large collection of spores at the end of the basidium, the spores that are pushed aside lying adjacent to the second one along their entire length (Fig. 7).

When spores are sown in pure water they exhibit a phenomenon which can scarcely be called anything but budding (Figs. 1–5, 7, 8, p. 103). They become once septate, and while one division sends out a germ tube the other gives rise to another spore, separated from the first only by a short neck. The germ tube also frequently sends out a spore just beyond the point where it leaves the spore (Figs. 3, 5, p. 103). By the time a spore has been two days in water the cell that at first gave rise to the germ tube may also have produced several spores, either by budding or upon a short thread.

Secondary dark colored spores (Fig. 6, p. 103) are also often produced in great numbers both when the spores are germinated in water and in nutritive media. In the latter they are sometimes so abundant as to give the mycelium a dark color when seen by the naked eye. These bodies are usually regular at first, but become very irregularly lobed and even reproduce themselves by constriction. They also give rise to other mycelial filaments. I do not understand their special function.

GENERAL NOTES.

Just how long the disease has existed or has been a source of trouble to cotton growers can not well be ascertained; but those who have written us concerning it speak of it as new, and it is safe to say that it has greatly increased in destructiveness during the last three years and has now become a source of danger to the cotton industry.

It was first brought to our attention in the summer of 1888 by a letter from a cotton grower in Louisiana. Last year, we received no complaints in regard to it, but during the last few months repeated inquiries have been sent in, and in two cases, one from Alabama and one from Louisiana, it is reported as destroying 75 per cent. of the crop. In general, however, it seems to destroy from 10 to 25 per cent. The disease is evidently not a new one, as a specimen dating back five or six years has been found in the Department herbarium. In this case, however, only a saprophytic fungus which had nearly overgrown the true cause of the trouble was named on the label.

It seems to have appeared at first on the improved varieties and is worse in wet seasons. That it is widespread is evidenced by the fact

E.A.S. del.

SOUTHWORTH ON ANTHRACNOSE OF COTTON.

Colletotrichium gossypii, n. s.

that it has been reported to us from Arkansas, Louisiana, Indian Territory, and Mississippi.

From the nature of the disease there is every reason to fear that it will be very difficult to prevent by fungicides. Anthracnose of the grape is more obstinate than black-rot, and no well defined, certain remedy is yet known for it. The treatment of anthracnose of beans and melons has been attempted on a small scale and has failed completely. The hollyhock disease has been only partially prevented by the use of fungicides that would have succeeded perfectly with black-rot of grapes or leaf-blight of pear. In some of these cases, however, a partial success has been attained and the indications are that the proper use of Bordeaux mixture may finally conquer even this type of fungus.

The vitality of the fungus as shown by its reviving after drying, and the power of the spores to reproduce themselves, are very sure indications of one mode of preventive treatment, viz, the removal from the field of all diseased bolls as soon as possible. A worthless boll will be likely to produce fresh spores with every rain, and if left over winter in the field will probably prove a source of infection the following season, for each spore is capable of infecting a fresh boll. One infection experiment was made on three healthy bolls. The spores were inserted in a cut and the fungus was produced in great quantities all around the cut. The value of this experimment was lessened by the fact that the fungus also appeared on one of the check bolls and that all were taken from a field in which the disease was present. The fact, however, that on the infected bolls the fungus was confined to the vicinity of the cuts is evidence that it was caused by the inserted spores.

Plans are being made to test the value of fungicides in checking this disease during the next cotton-growing season.

EXPLANATION OF PLATE.

Colletotrichium gossypii, n. s.

Fig. 1. Section through old fruiting layer, showing the setæ borne on dark-colored cells, above the level of the basidia; *a a*, enlargements of setæ near the end. X 360.

Fig. 2. Section through younger portion of fruiting layer. Two setæ bearing spores. X 600.

Fig. 3. Section showing stroma mixed with tissues of the boll. X 800.

Fig. 4. Spores; *a a*, borne on basidia. X 600.

Fig. 5. Filiament of mycelium passing through cell wall. X 800.

Fig. 6. Portion of artificial mycelium bearing setæ at *a* and *c*, and at *b* basidium with immature spore. X 600.

Fig. 7. Different stages in the formation of spores in artificial culture. X 600.

PERENNIAL MYCELIUM OF THE FUNGUS OF BLACKBERRY RUST.*

Plates V, VI.

By F. C. Newcombe.

In May of the present year, at the suggestion of Mr. Galloway, a plant of *Rubus villosus* affected with *Cæoma nitens*, Schw. was examined with a view to ascertaining whether there is a perennial mycelium.

A shoot of the blackberry was selected whose lowest leaf bearing the rust was 16 centimeters from the rooting portion of the stem. Beginning with the leaf, cross and longitudinal sections were made, at intervals of 2 centimeters, down to the roots.

At every place of section the characteristic mycelium was found. In one instance the mycelium was observed in the medullary rays; in every other case in the pith only. It is septate, intercellular, and coarsely granular. It looks active and vigorous in the old stem as well as in the green shoot. But the most striking part of it is the haustoria. These are found of the same appearance in leaf, green shoot, and old stem. Penetrating the cell wall by a narrow neck, in the cell-lumen a haustorium expands to a large, lobed and knotted, club-shaped body whose diameter exceeds that of the mycelial filament and whose length frequently attains the transverse diameter of the host cell. In longitudinal sections the mycelium can be followed for long distances in the direction of the shoot axis, not often branching laterally, but sending its great haustoria in all directions into the adjacent cells of the host. Not infrequently the mycelium is seen to form a pseudoparenchyma in the intercellular spaces.

These observations were repeated on fresh material gathered near Ann Arbor the latter part of June.

NOTE BY B. T. GALLOWAY.

Mr. Newcombe's observations have an important bearing on the treatment of blackberry rust, as they indicate that no direct benefit would result from the application of fungicides. Some writers† have claimed that the fungus does not live over winter in the root and stems, and if this were true it would seem possible to prevent the disease by the timely application of fungicides. Field experiments have shown that such applications, no matter how carefully made, have little effect so far as diminishing the amount of rust is concerned.

It is obvious that the immense number of spores, which form the reddish powder so familiar to every one, plays an important part in the life history of the fungus, and by destroying these spores, spraying may, indirectly, result beneficially. It is doubtful, however, if spraying with this object only in view will pay in the end. After all, it seems that

* *Cæoma nitens*, Schw.

† Burrill, Prairie Farmer. 1885, p. 762. Seymour, Rept. State Hort. Soc. Minn 1886, p. 214.

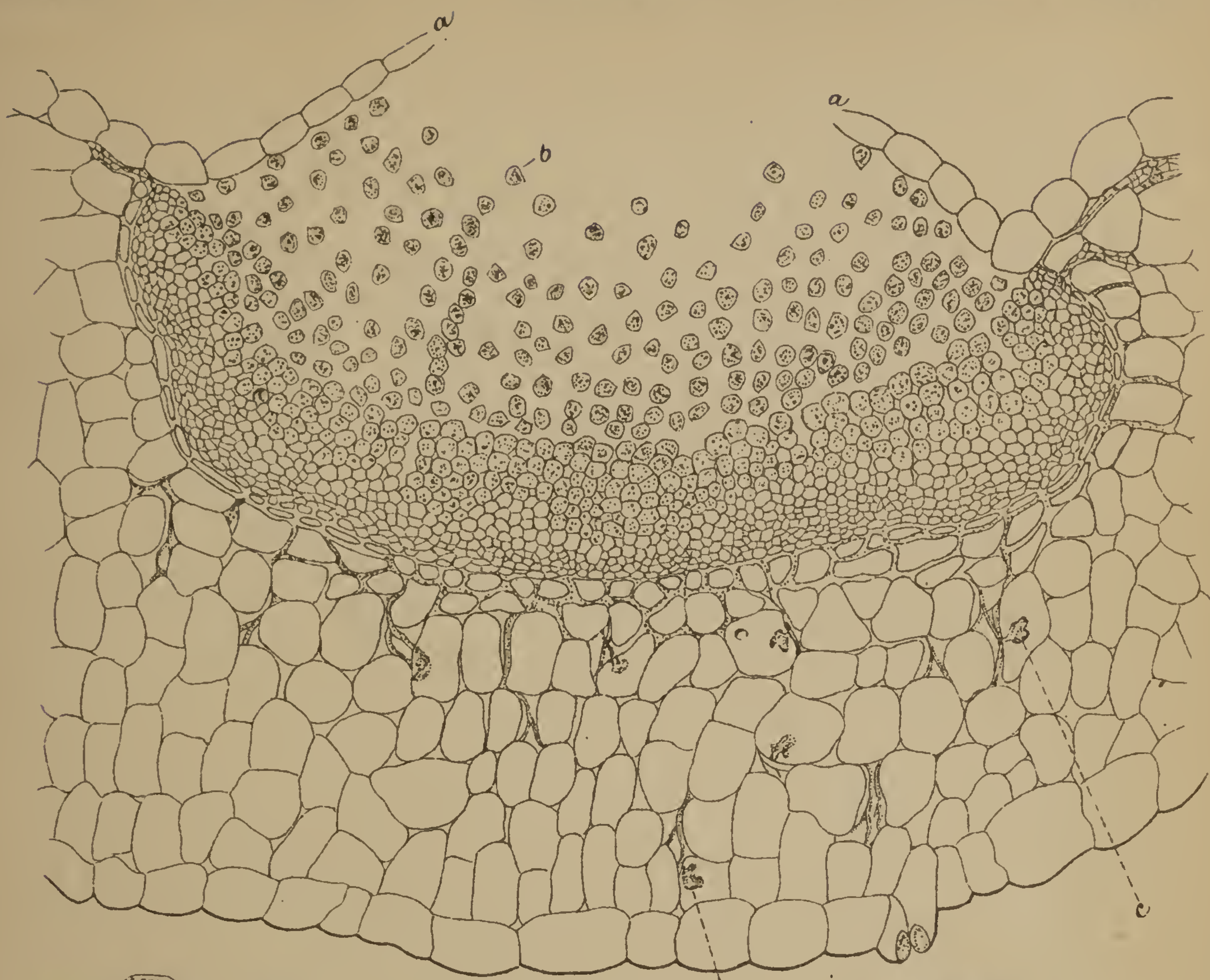


FIG. 1

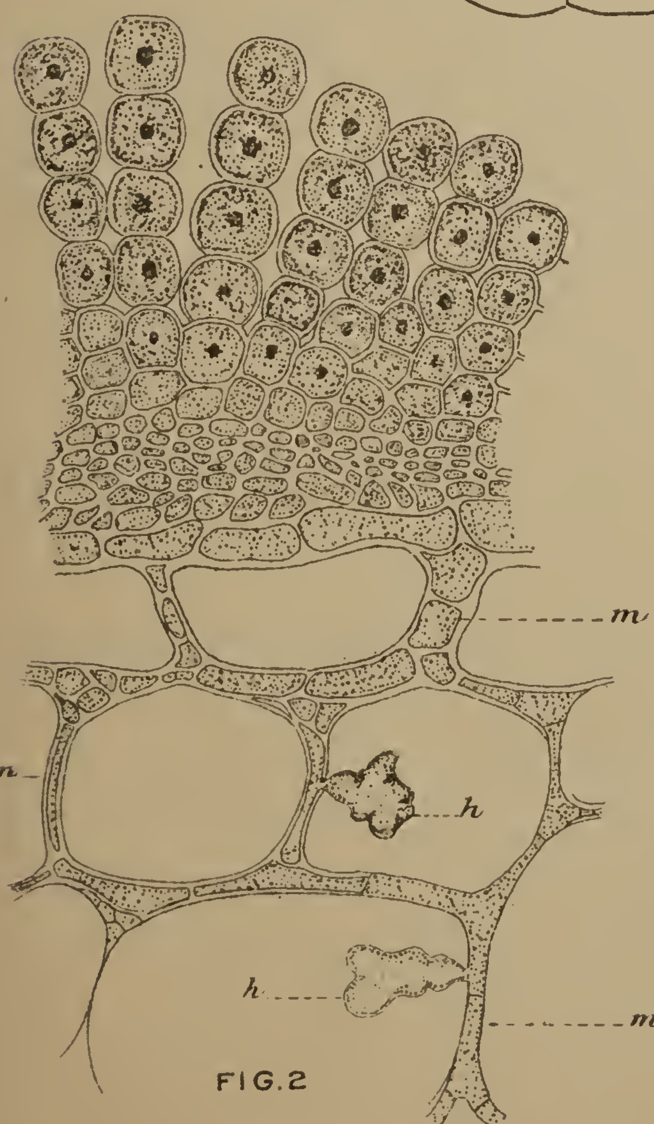


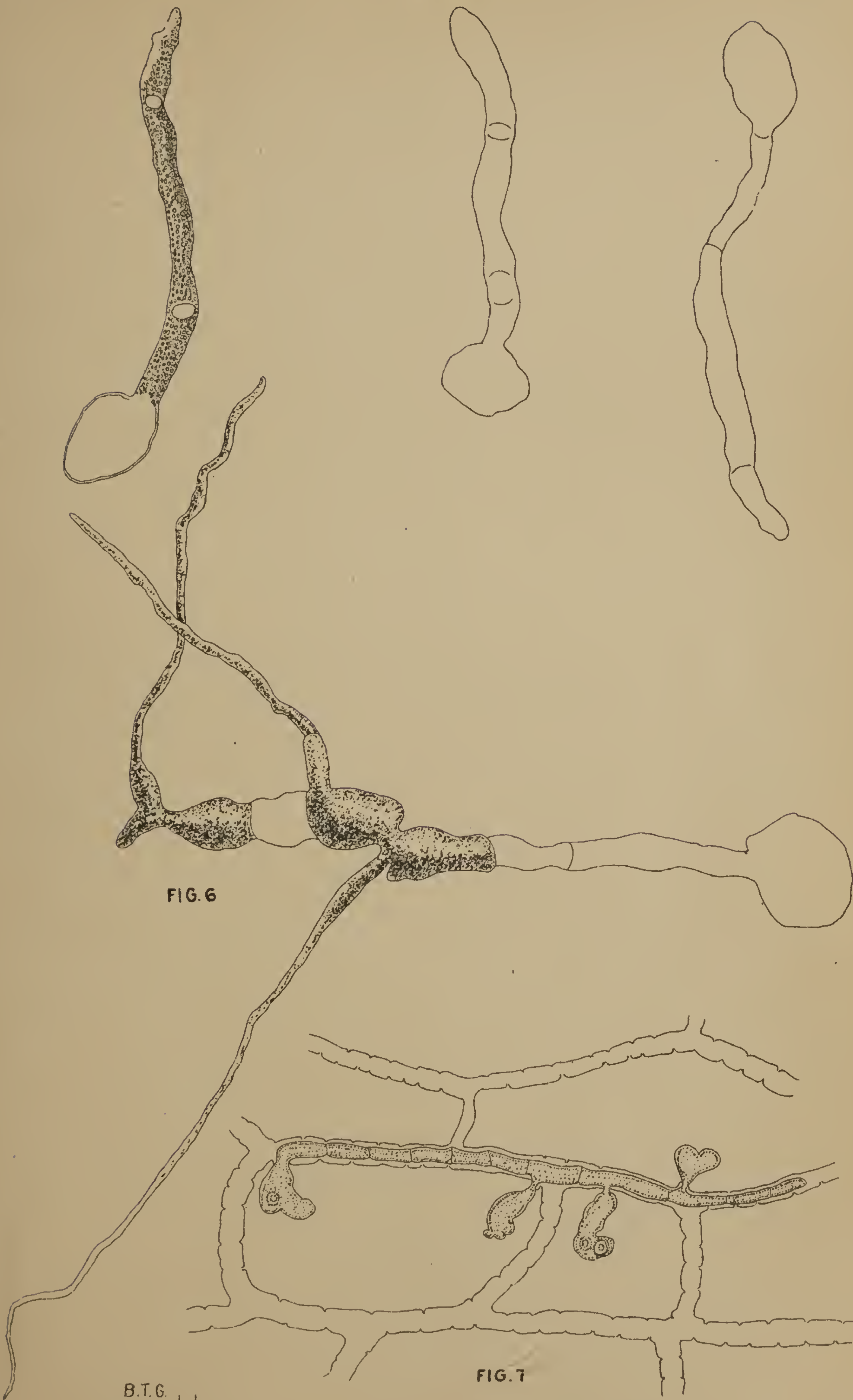
FIG. 2

FIG. 3

FIG. 4

F. C. N. del.

NEWCOMB ON BLACKBERRY RUST.
Cæoma nitens. Schw.



NEWCOMB AND GALLOWAY ON BLACKBERRY RUST.
Cæoma nitens. Schw.

the only practical and efficient method of dealing with this pest is the old one of grubbing out the affected plants as soon as they are noticed. It would be well, also, to discard those varieties known to be subject to the trouble.

EXPLANATION OF PLATE.

BLACKBERRY RUST (*Cæoma nitens*, Schw.).

Fig. 1. Section through portion of leaf affected with rust; *a a*, ruptured epidermis showing below at *b* the mass of spores; *c c*, haustoria. By means of these the fungus draws its nourishment from the cells. X 100. Newcombe.
Fig. 2. Part of section more highly magnified; *m m m*, mycelium surrounding cells of the host; *h h*, haustoria projecting within the cells. X 300. Newcombe.
Fig. 3. Spores. X 600. Newcombe.
Fig. 4. Section through spermogonium. X 300. Newcombe.
Fig. 5. Spores germinating; 24 hours in water. X 250. Galloway.
Fig. 6. Spore germinating; 60 hours in water X 300. Galloway.
Fig. 7. Section through piece of old underground stem, showing perennial mycelium and haustoria. X 300. Newcombe.

FIELD NOTES—1890.

By Erwin F. Smith.

The field naturalist often discovers interesting phenomena not immediately related to his own work—phenomena too fragmentary to be worked up separately, and yet sometimes of much value to others if accurately observed and duly recorded. Such must be my apology for the greater part of the following "notes by the way."

PEACH-LEAF CURL.*

Heretofore, in this country, California orchards are the only ones that have been seriously affected by this widely distributed fungus. This spring, however, it caused great injury in certain districts east of the Mississippi River, and was more than usually prevalent in all the principal peach regions of the eastern United States. It was most destructive in central Michigan and western New York, defoliating trees by the thousand in both localities. By the last of June the fungus had nearly disappeared, and the trees had partially recovered and were clothed with a second crop of leaves. But even in July the effects were plainly visible in enfeebled growths, yellowish foliage, and stunted fruits. Certain varieties suffered much worse than others, *e. g.*, Crawford's Early. It seemed to me it would take some of the trees several years to recover.

In Delaware and peninsular Maryland the fungus was unusually common, but the orchards were not defoliated nor badly attacked. I also observed traces of the disease in Georgia in midsummer, but it did not appear to have attracted attention or caused serious injury.

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* *Taphrina deformans*, Tul.

During 1887, 1888, and 1889, this fungus was rare in the great peach region between the Chesapeake and Delaware Bays. Often weeks passed without my seeing a single affected leaf, although I spent much of my time in the orchards. This struck me the more forcibly because in Michigan I had formerly observed the curl to be common every spring. This season, on the contrary, it could be collected in any peninsular orchard. In one only, however, did I find it serious. This was an old, abandoned orchard in sod ground, pastured. Here in May nearly every leaf was white, thick, and distorted, and many were falling. At a distance the foliage was not green, but yellowish white. Younger cultivated orchards on the same farm were nearly free.

PLUM TAPHRINA.

In Maryland and Georgia this disease was also very prevalent on *Prunus Chicasa* and its cultivated varieties. I have been accustomed to call this fungus *T. pruni*, but the injuries differ somewhat from those I have seen on *Prunus Americana* in the North and West. This fungus is much more inclined to thicken, distort, and unite the leaves and growing shoots. The "plum pockets" are also absent. The fruits often suffer, but the fungus generally attacks only one side, forming a hard, solid spot, which ripens imperfectly. From what I saw in the plum orchards of Georgia, and was told, this fungus is an enemy of some importance in that region. Is it specifically distinct from the pocket forming sort?

PLUM BLIGHT.

A peculiar disease, now prevalent several years, in a large plum orchard of native sorts at Griffin, Ga., deserves further study. This disease destroys large branches or whole trees in midsummer in the course of a few weeks. I saw many fine trees of bearing age entirely ruined. The foliage was drying up as if scorched, or as if the limb or body had been girdled. No fungous or insect enemies were observed, and there were no mechanical injuries. The surface bark on the trunk and base of the main limbs was smooth, unbroken, and usually normal in appearance, but upon cutting into it I always found large dead patches which sometimes entirely girdled the trunk or branch. These were often several inches wide by 1 or 2 feet long. Evidently the sudden drying and death of the remoter parts is due to interference in the circulation brought about by the presence of these bark injuries. Their origin, however, is still a mystery. There did not appear to be any injuries below ground. Indeed the injured trees usually sprout again vigorously from the earth.

The loss this year in an orchard of about 6,000 bearing trees amounted to more than 5 per cent. The owner said 10 per cent. The loss last year was nearly as great.

APPLE BLIGHT.*

Never before have I seen this disease one-tenth part as destructive. In middle and north Georgia the apple trees were badly spotted by it. The injury was not confined to twigs, but affected branches of several years' growth, greatly injuring next year's fruit prospect. The disease was also common in Pennsylvania, where in other years I have found it common, although confined principally to the twigs. In Michigan it was not seen. In Kansas it was worse even than in Georgia. At Manhattan I was shown several young and thrifty orchards of bearing age which had been sadly injured. The attack began in 1889 and continued this year with increasing severity. The disease was not confined to twigs, but often destroyed large limbs and in some cases one-half or even the whole of the tree, as in pear blight. The owner was in despair. Certain varieties were noticeably worse injured than others. This was found to be true for different orchards and both years. Certain sorts escaped almost entirely.

PEAR-LEAF BLIGHT. †

In Dr. W. S. Maxwell's orchards the Lawrence and Bartlett pears in *sod* ground were very slightly attacked. They held their foliage practically intact until October 15. The cultivated trees were badly affected and shed their foliage early, except Keifer, which did not suffer. I observed this fungus at Still Pond, Md., in 1887, in these same orchards and elsewhere. and also in other parts of the peninsula, but it was not destructive and was not then considered of any consequence by any of the pear growers. Now they are all talking about it.

This year quince and pear orchards all over the Delaware and Chesapeake peninsula were seriously defoliated, and, as a consequence, were quite commonly in second leafage and blossom in October. The injury last year was also very great, amounting in some large orchards to an almost total loss of the crop.

BLACK ROT.‡

In Georgia and Kansas the summer was hot and dry. Vineyards in both States ripened a large and fine crop of fruit, which was almost free from rot. Enough *Læstadia* could be found for specimens, and the same was true for *Peronospora viticola*, but neither did any injury.

In Delaware there was also a long drouth in midsummer and black rot was not seriously destructive.

VINE BLIGHT.§

In good soil in one corner of a fine bearing vineyard near Griffin, Ga., twenty-five or thirty thrifty vines suddenly sickened in midsummer and

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**Bacillus amylovorus*, (Burrill) Trev.

† *Entomosporium maculatum*, Lév.

‡ *Læstadia Bidwelli*, (Ell.) V. and R.

§Later this blight was attributed to lightning, by the owner and others, who said lightning had also caused a similar appearance in the cotton fields.

died, in whole or part, in course of a few weeks, without apparent cause. The foliage lost color and wilted, the clusters shriveled, and the canes turned black. No fungous or insect enemies could be seen.

The vines were trained up on stakes and the vineyard had received proper care and cultivation. The soil was well drained upland. The cases were not all in one spot, but scattered about. The malady in its sudden appearance and destructive nature called to mind the mysterious vine disease of California, but did not agree with it in all particulars. At my suggestion the vines were promptly removed and destroyed.

BROWN ROT OF THE PEACH.*

Owing to the phenomenal scarcity of stone fruits in peach districts east of the Mississippi, this fungus was rare, except on old fruits. I saw it once at Lansing, Mich., on nascent plum shoots, but not elsewhere.

PEACH YELLOWS.

In southwestern Michigan there was an increase of the disease around Fennville, but not elsewhere, so far as I could hear or observe.

On the Delaware and Chesapeake peninsula this disease was worse than any previous year. The marked diminution of new cases in 1889 was coincident with a partial failure of the crop. It therefore seemed possible that here might be a clue to the cause of the disease. This year, however, with an entire failure of the crop the number of new cases were in excess of those in 1886, 1887, or even 1888, when the orchards bore most abundantly. Fruit or no fruit, the disease increases.

The cases by years in four representative Delaware orchards (my own count) are as follows:

Year.	Weather in summer.	Cases.			
		30 acres set in 1882.	10 acres set in 1885.	2 acres set in 1884.	10 acres set in 1884.
1887	Wet	*260	†32	†36	†27
1888	Dry	314	71	47	54
1889	Wet	255	63	6	37
1890	Dry	856	118	90	87

* A very few cases belong to 1886 when the disease first appeared. † First cases.

THE PEACH ROSETTE.

A new peach disease, or an old one in a new form, has made its appearance in Georgia and Kansas and bids fair to become very serious. One Kansas orchard was destroyed in two years, and certain Georgia orchards have suffered almost as badly. In some particulars this disease is identical with peach yellows; in others it differs somewhat. The disease occurs also in plums, wild and cultivated, and is equally destructive. A full account is reserved for separate consideration.

* *Monilia fructigena*, P.

THE RELATIONSHIP OF PUCCINIA AND PHRAGMIDIUM.

By Prof. G. de Lagerheim.

As a distinctive difference between Puccinia and Phragmidium, Tulasne* asserts that the teleutospores of the first genus are only provided with one germ pore, while those of the second possess several which are equatorially arranged. Since then, however, Dietel † has shown that this is not the case in all Phragmidiums, but that in *Ph. obtusum*, Winter, each cell of the teleutospore is provided with only one germ pore situated at the upper end of the cell exactly as in the genus Puccinia. *Ph. abidum*, Ludwig, appears to form a transition between the two types.‡ It should also be mentioned that in *Ph. Barnardii*, Plowright & Winter, and in *Ph. carbonarium*, Winter, the end cell is provided with an apical pore. Besides these characteristics, which are, as we see, unreliable, *Phragmidium* is distinguished from *Puccinia* by the number of cells in its teleutospores and by the different structure of its *Æcidia*. But in several Puccinias we occasionally find many-celled teleutospores, and therefore this character is not constant. On the contrary the difference in the structure of the æcidium appears to be a constant mark of distinction. The æcidium of Puccinia is provided with a pseudo-peridium, while that of Phragmidium is not; and in the latter the spores are cut off from basidia and surrounded only by a row of paraphyses as in the genus Melampsora. §

In the above-mentioned work Dietel has attempted to establish the the fact that *Phragmidium* is more closely related to *Chrysomyxa* than to *Puccinia.* But in comparing the two genera which he considers to be related he has forgotten to notice the difference existing between their æcidia and uredo stages. As has been said, the æcidium of *Phragmidium* has no pseudo-peridium, while one is present in the æcidium of *Chrysomyxa.* The structure of the uredospores of the two genera differs even more. In *Phragmidium*, as in *Puccinia* and *Uromyces*, they arise singly at the end of a mycelial thread, while on the other hand in *Chrysomyxa*, as in *Coleosporium*, they are borne in rows. I am therefore inclined to believe in a closer relationship between *Puccinia* and *Phragmidium* than between *Chrysomyxa* and *Phragmidium.* This supposed relationship would become still clearer if one could find a *Phragmidium* with a Puccinia-æcidium or a *Puccinia* with a Phragmidium-æcidium or with several equatorial germ pores. We can probably regard the genus *Rostrupia* || as a *Phragmidium* with a Puccinia-æcidium. The teleutospores

* Ann. de Sci. Nat. Ser. 4, t. II, p. 146.

† Beitrage zur Morphologie und Biologie der Uredineen t. II, 9. Figs. 3–7. (Cassel, 1887.)

‡ Compare Dietel, l. c., t. II, Fig. 10, and Müller Die Rostpilze der Rosa und Rubusarten und die auf ihnen vorkommenden Parasiten t. I, fig. 9 (Berlin, 1886).

§ The genus *Calyptospora*, Kühn, is not to be united with *Melampsora*, because, as is known, the Calyptospora-æcidia have a pseudo-peridium.

|| Compare Lagerheim, Sur un nouveau genre d'Urédinieés (Journ. d. Botan., 1889), Paris.

of this genus are as a rule 3–4 celled, and the uredospores are formed in the same way as in Phragmidium (and Puccinia). The æcidia of *Rostrupia* are unfortunately not known, but judging from its great similarity to certain grass inhabiting Puccinias it is very probable that the æcidia are formed as in *Puccinia* and *Uromyces*. A Puccinia with a Phragmidium-æcidium is not known, although it is not impossible that such a one exists. On the other hand there is one Puccinia, or perhaps several, which shows a condition of the germ pores typical for *Phragmidium.*

There are several *Uredineæ* on Barberry species. Besides the well known æcidium of *Puccinia poculiformis*, Wettstein (*P. graminis*, Persoon), there probably occur three æcidia upon Barberry, namely, *Ae. Magelhænicum*, Berkeley,* æcidium of *P. berberidis*, Montagne, and an æcidium which appears to belong to a *Diorchidium* frequent around Quito on *Berberis glauca.* The genus *Uromyces* is represented on Berberis (Mahonia) by one species, *U. sanguineus.* Besides the above mentioned, *P. berberis*, Mont., two Puccinias, *P. mirabilissima*, Pk. and *P. antarctica*, Speggazzini, have been observed on Barberry. Finally two uredo forms are found on Berberis, namely, *U. æcidiiformis*, Speggazzini and *U. antarctica*, Speggazzini.

Puccinia mirabilissima was described by Peck in the Botanical Gazette for 1881, p. 226. Tracy and Galloway gave further information concerning it in the Botanical Gazette for 1888, p. 126, and De Toni gives the following diagnosis of the species (Syll. Ured., p. 620).

Maculis late purpureis 3–4 millimeter diameter, leniter incrassatulis, pseudoperidiis hypogenis, longis, pallide flavis, margine grosse laceratis; æcidiosporis subglobosis, 15-20 μ diameter, tuberculatis; maculis parvis, punctiformibus vel majusculis subrotundisque, superne atris vel atrobrunneis; soris hypophyllis, paucis, minutis pallide rufescenti—brunneis; uredosporis subglobosis, obovatis vel piriformibus, obtusis, minutissime rugulosis; 22–33 by 20–23 μ pedicello hyalino, dein deciduo; teleutosporis immixtis, ellipticis, obtusis, ad septum constrictis, subtiliter rugosis, 30–32 by 22–25 μ pedicello longissimo hyalino fultis.

The species is found in several places in the United States on the leaves of *Berberis repens*, and has been distributed in Ellis's North American Fungi, No. 1451, and Rabenhorst-Winter-Pazschke's Fungi Europaei, No. 3619.

In the following I will give the results of my investigations with specimens distributed in Fungi Europæi. They were collected at Thompson Falls, Montana, September, 1884, by Seymour, and in Sierra Nevada, California, May, 1886, by Harkness. Uredo and teleutospores, but no æcidia, were present; the uredospores from the Montana specimens were more or less ovate, those from California piriform.† When treated with warm potash or lactic acid the epispore swelled up so

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**Aecidium graveolens*, Shuttleworth, is really identical with *Ae. Magelhænicum* Berkeley.

† Compare Lagerheim "L'acide lactique, excellent agent pour l'etude des champignons secs" (Rev. Mycol. No. 42). Toulouse. 1889.

that it could easily be shown to consist of three layers. The outer layer is very thin, colorless, and covered with fine warts; the middle layer is the thickest and is yellowish and smooth; the inner layer appears tolerably firm and is also yellowish and smooth. The uredospore is provided with from three to four equatorial germ pores, and the membrane is not equally thick everywhere, but is not especially thickened at the base of the spore. Treated in the same manner the epispore of the teleutospores showed the same three layers; the warts on the outer layer are somewhat larger and do not stand so close together as on the uredospores. The teleutospores are characterized by a long hyaline pedicel which breaks off at the base and remains in connection with the spore. The pedicel tapers below and is hollow in the lower portion. It is not perfectly smooth everywhere, but a small wart occurs here and there. Probably Peck called this species *mirabilissima* on account of the strikingly long pedicel, but it deserves this epithet in a still higher degree on account of another peculiarity that has been hitherto overlooked. One of the main characters of the genus *Puccinia* is, as we know, that each cell of the teleutospore is provided with but one germ pore which can have different positions, but in *P. mirabilissima* this is not the case, for here is each cell of the teleutospore with two opposite germ pores. These show plainly when the spores are treated as above mentioned. In this respect *P. mirabilissima* varies from all other Puccinias that have been carefully observed, and even in this peculiarity I see a point of union between the genera *Puccinia* and *Phragmidium*. It would be of interest to study the germination of this peculiar species, and it is to be hoped that some one of my North American colleagues, to whom living specimens are accessible, will undertake it.

QUITO, ECUADOR.

NOTES.

A NEW PEAR DISEASE.

Something over a year ago we received from one of our correspondents in southern Alabama a number of pear branches affected in a peculiar manner. In a letter sent with the specimens our correspondent described the disease as follows:

> The disease appears in the form of spots on the trunk of the tree, always at a dormant bud, also on the branches at the base of another branch or fruit spur. The spots when first noticed were about one-quarter of an inch in diameter, but soon increased to four or five times this size. They are nearly round and are surrounded with whitish uneven edges. When one-half an inch or more in diameter the affected portion becomes depressed and upon cutting into it the bark cambium and a considerable portion of the wood is seen to be brown and dead. In no case has the affection entirely encircled a branch or trunk, but I have no doubt that if allowed to continue it will do so in a short time. I have never seen the disease before and fear it will prove troublesome in my orchard.

Upon examination of the specimens it was found that the disease was due to a fungus known as *Thelephora pedicellata*, Schw. We have this

parasite, for so we must regard it, from New Jersey on oak (*Quercus cocinnea*), Florida on palmetto (*Sabal palmetto*), and Texas on cultivated apples. From this it will be seen that it is not particular as to hosts or locality. There is no doubt that on trees having such soft, tender bark as the pear and apple the fungus will readily obtain a foothold and prove a very serious enemy. An allied species (*T. perdix*, Hartig) occurs in Europe on oak, causing what is known as "partridge wood." In this case the wood becomes a deep brown; then white spots appear upon these discolorations, giving to the affected parts a mottled appearance, hence the name.

To our correspondent's inquiries concerning the cause of the disease and its treatment we gave in reply to the first question substantially what is stated in the foregoing remarks, suggesting by way of an answer to the inquiries concerning treatment that he cut out all the diseased wood and, after washing the wounds thoroughly with a saturated solution of sulphate of iron or copperas, apply grafting wax or something similar. Our suggestions were complied with to the letter, excepting that a coat of shellac dissolved in alcohol was used instead of grafting wax.

A few days ago we received a note from our correspondent saying that the treatment had proved entirely successful. The wounds healed readily and the trees which a year ago bore every indication of approaching death are now as vigorous as any in his orchard.—B. T. GALLOWAY.

DISEASE OF GERANIUMS.

For a long time we have noticed a disease of geraniums which attacks the stems, causing them to turn black, shrivel, and sometimes become soft and mushy. The trouble is not confined to any particular variety, nor does it seem to be influenced to any great extent by soil or climate. It is a very troublesome thing in greenhouses, especially among cuttings, which it often destroys by the thousand. Cuttings attacked by the disease begin to turn black at the severed end, the discolorations rapidly extending upward until the whole stem is involved. Occasionally the disease stops after an inch or more of the cutting is destroyed; but even if this takes place the plant eventually dies as soon as the supply of nourishment in the green portion is exhausted. Cuttings rooted in the bench are not so apt to suffer from the disease as those immediately potted. The disease is also more troublesome where immature wood is used and when too much water is applied immediately after the cuttings are potted.

Microscopic examination of the diseased tissues has so far revealed nothing in the shape of a fungus excepting where the wood has become soft, where, as might be expected, a number of saprophytic forms occur. Sections through portions of the stem as at *a* Fig. 1, where the disease is actually at work, reveals under the microscope immense numbers of bacteria, in some cases almost filling the cells and often escaping into the water in sufficient numbers to make the latter appear milky.

Cultures made from the diseased wood on gelatine, agar-agar, potato, etc., usually show at the expiration of from 24 to 48 hours numerous colonies of bacteria which are for the most part of one kind, namely, a *Bacillus*.

As yet no inoculations have been made with the organism itself, but the disease has been produced in a number of cases by inoculations directly from diseased wood. Figure 2 shows the result of one of these inoculations, *a* being the point where the knife entered the tissue. The disease is one certainly worthy of careful investigation, as the losses in one establishment last year in this city amounted to over 50 per cent.

FIG. 1.

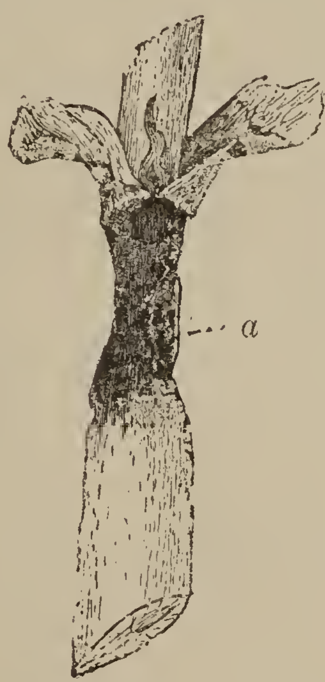

FIG. 2.

FIG 3.

Our object in writing this preliminary note is to call the attention of florists and others directly interested in the matter to the work we now have under way and to obtain from them any information bearing on the subject they may consider of value.

A disease which may be the same as the one here referred to has recently been reported from France by Messrs. Prillieux and Delacroix.*

According to these writers *Pelargonium* and potato stems are affected with a malady which causes them to turn black and become rotten. The disease has been transferred from the potato to the *Pelargonium* and vice versa. A *Bacillus*, which the authors believe to be the cause of the trouble and which has received the provisional name of *B. caulicolous*, Pr. and Del., has been found associated with the disease. No mention is made of the disease having been produced by inoculating with the organism, although it is claimed that this can readily be done by direct inoculation.—B. T. GALLOWAY.

ADDITIONAL OBSERVATIONS ON ANTHRACNOSE OF THE HOLLYHOCK.

Since the last issue (Vol. VI, No. 2) of the JOURNAL OF MYCOLOGY some additional facts have come to light concerning the *Colletotrichium* on the hollyhock.

* Comptes Rendus t. CXI, p. 208.

A fungus exactly like it in appearance has been found on *Sida spinosa* by Mr. W. T. Swingle at Manhattan, Kans. Some attempts at producing the disease on hollyhock by the spores from *Sida* have been made, but as far as known they have not been successful. This might easily be accounted for by the lateness of the season and consequent low temperature, and it seems almost certain from a comparison of the fungi that they belong to the same species.

Dr. P. A. Saccardo writes that the fungus is probably not a new species at all, but was described in 1854 by Braun and Caspary as *Steirochæte malvarum* on *Malva* in Europe (Sacc. Syll., IV, 316). The descriptions certainly agree in many respects, but the description in the Sylloge reads, "Conidiis ex pseudostromate immediate (ut videtur) orientibus," and the spore measurements are given as 8–9 x 3–4 μ. In the fungus on hollyhock there was no question as to the spores being borne on basidia and they measured 11–28 x 5 μ. The fact of the spores being borne an basidia may, however, have been overlooked, and as the spores vary greatly anyway, the difference in size is not sufficient reason for making a new species.

After comparing the two descriptions it seems very probable that the fungus must stand as *Colletotrichium malvarum*, (Br. & Casp.).

There also seems to be a possibility that *Steirochæte graminicola*, (Ces) Sacc. may be identical with *Colletotrichium bromi*, Jennings, an undescribed species on *Bromus secalinus*, noted in Bull. 9 of the Texas Experiment Station.—E. A. SOUTHWORTH.

LEPTOTHYRIUM PERICLYMENI, DESM.*

Specimens of what seemed to be this species on *Lonicera*, sent this season from Perry Sound, Ontario, Canada, by Mr. Dearness, have the sporules (pseudo) septate near the lower end and agree accurately with the description and specimens of *Marsonia loniceræ*, Hark., except in being mostly shorter ($22-30 \times 7-9\mu$). European specimens in Thüm. M. U. 1893, Kunze, F. Sel. 591, Linhart 474 and F. G. 4674 do not show any septum, though the F. G. specimens show some indications of one. The European specimens also have the sporules less attenuated below. In the specimen from Dearness and Harkness the lower part of the sporule is so much narrowed as to appear like a stipe or pedicel. The Canadian and Californian specimens are certainly the same and can not be referred to *Marsonia*, as they have a very distinct scutellate perithecium of radiate fibrous texture. We propose to designate the American form as *Leptothyrium perichymeni*, Desm. var. *Americanum*, E. & E.—J. B. ELLIS and B. M. EVERHART.

A NEW USTILAGO FROM FLORIDA.

USTILAGO NEALII, Ell. and Anders., n. s. On *Heteropogon melanocarpa*, Lake City, Fla. Prof. J. C. Neal, collector, 1890.

Attacking the inflorescence. Spore masses firm, blackish brown, fill

*Sacc. Syll. III, p. 626.

ing the ovaries, frequently transforming a whole spikelet into a solid mass of spores enveloped in a whitish to buff-colored tegument. The lower lateral solitary spikelets, when attacked, are changed into irregular roundish knots, or nodules, as large a medium sized pea. Spores roundish, oblong, oval or ovate and variously compressed; contents pale olivaceous, epispore smooth, reddish brown; general color of spore a bright warm brown, slightly olive tinged, 6–10 μ wide, by 6–14 μ long. J. B. ELLIS and F. W. ANDERSON.

REVIEWS OF RECENT LITERATURE.

KELLERMAN, W. A., AND SWINGLE, W. T.—*Preliminary experiments with fungicides for stinking smut of wheat.* Bulletin No. 12.—August, 1890. Botanical Department of the Experiment Station, Kansas State Agricultural College, Manhattan, Kans.

The wisdom of the recent establishment of State experiment stations by the General Government has been called in question in certain quarters. Nevertheless, the stations are here to stay, and their public usefulness becomes more and more apparent, especially after reading such a paper as this from the Kansas station. The results are striking and conclusive, and worth more to the wheat-growers of this country than the cost of all the stations.

In the main these experiments are a repetition and confirmation of those made in Europe by Jensen, Kühn, and others. Fifty-two treatments were given for the prevention of stone smut in wheat (*Tilletia*). The substances experimented with were:

Hot water of various temperatures; lye of different strengths; solutions of copper sulphate with and without lime, and of different strengths; Bordeaux mixtures, full and half strength; eau celeste; solution of sodium hyposulphite, with and without lime, and of different strengths; solution of potassium sulphide, with and without lime, and of different strengths; arsenic; lime; salt; soap; cistern water; chloroform; ether; sulphurous oxide; carbon bisulphide; ammonium hydrate; carbolic acid; sodium sulphate, bicarbonate and carbonate; potassium bichromate; mercuric chloride, and salicylic acid.

Fifty untreated strips, alternating with the treated ones and containing a total of 6,227 square feet, afford the basis for comparisons. The total heads produced on these 50 plats were by actual count 122,432, of which over seventy-one per cent. were smutted. The highest per cent. of smutted heads on any plat was 81.61 per cent.; the lowest was 53.54 per cent. The average number of bushels of sound grain per acre (calculated) on 41 of these plats is only 4.68. By an oversight no calculation was made for the other nine plats, but these were much like the rest, and the average of the fifty could not have varied much from that here given.

Undoubtedly the yield was smaller and the per cent of smut greater owing to the fact that the grain was sowed in November and made a slow and feeble autumn growth. In this connection it is interest-

ing to note that the per cent of smut was greatest on the latest sowings as the experiments of Brefeld would lead us to expect. The wheat was soaked in the fungicides or subjected to their vapors in case of chloroform, etc.

The experiments which proved most successful were as follows:

No. 13. Hot water 131–132° F., 15 minutes. Smutted grains skimmed off.
No. 15. Hot water 132–131° F., 15 minutes. Smutted grains not skimmed off.
No. 21. Copper sulphate, 8 per cent., 24 hours; not limed.
No. 23. Copper sulphate, 8 per cent., 24 hours; limed.
No. 25. Copper sulphate, 5 per cent., 24 hours; not limed.
No. 27. Bordeaux mixture, 36 hours.
No. 29. Bordeaux mixture, half strength, 36 hours.
No. 45. Arsenic, saturated aqueous solution, 24 hours.
No. 57. Copper sulphate, ½ per cent. solution, 24 hours.
No. 87. Potassium bichromate, 5 per cent. solution, 20 hours.

The following table shows at a glance what has been accomplished:

Plot.	Heads smutted.	Bushels of sound grain (calculated.)
	Per cent.	*Per acre.*
Average of the untreated	71.29	4.68
No. 13	0.13	14.37
No. 15	0.82	15.36
No. 21	0.36	....
No. 23	0.31	12.52
No. 25	0.00	13.54
No. 27	0.00	....
No. 29	0.06	....
No. 45	1.09	13.75
No. 57	0.74	....
No. 87	0.00	17.01

The authors recommend the Jensen or hot-water method as the best on the whole. This treatment did not destroy quite all the smut, but it killed none of the wheat grains, and gave the largest yield except No. 87, which was only a small plot. Full directions are given for making this treatment.

The bulletin shows evidence of unusual care in preparation and a visit to the station during the progress of the experiment led me to believe that particular attention was given to all the details of the experiment, which is one involving a very great amount of painstaking labor. The graphic illustrations deserve special commendation.—Erwin F. Smith.

NEW SPECIES OF UREDINEÆ AND USTILAGINEÆ.

By J. B. Ellis and B. M. Everhart.

Schrœteria annulata, n. s. In ovaries of *Andropogon annulatus* from India (Herb. of S. M. Tracy). Mass of spores brownish black, pulverulent. Spores in twos or occasionally in threes, flattened on the line of contact, hyaline and 12–15μ diameter at first, becoming brown and separating into two distinct spores 7–10μ diameter. Epispore smooth or nearly so.

SCHIZONELLA SUBTRIFIDA, n. s. N. A. F. 2266. In flowering heads of *Cirsium ochrocentrum*. Wet Mountain Valley, Colo., July 25, 1888. Rev. C. H. Demetrio. No. 162. Spores violet or purple brown, subglobose or elliptical, soon becoming uniseptate and finally separating into two hemispherical segments. Epispore strongly tubercular-roughened, 12–20 by 12–16μ. Occasionally spores are seen with a triradiate septum much the same as in the spores of *Triphragmium clavellosum*, Berk., and in this case the spore separates into three parts instead of two, but the great majority of the spores are bifid. The fungus occupies the whole interior of the flowering heads, which become hollow and abortive.

USTILAGO DIPLOSPORA, n. s. In ovaries of *Panicum sanguinale*, Holly Springs, Miss., September 1890. Tracy No. 1551. Mass of spores dark brown. Spores of two kinds, the smaller ones globose, rough, brown, 7–8μ diameter, the larger ones 12–15μ smooth, globose, pale, nearly hyaline.

USTILAGO MONTANIENSIS, n. s. On *Muhlenbergia glomerata*, Sand Coulee, Mont., December 1887. Leg. Anderson. In the inflorescence which is rendered abortive and remains inclosed in the sheaths of the leaves. Mass of spores dark brown, nearly black. Spores subglobose, 10–14μ diameter or oblong or ovate oblong, 12–16 by 10–12μ epispore subtuberculose-reticulated, pale-brown.

ÆCIDIUM MICROPUNCTUM, n. s. On *Castilleia* from Pine Ridge, Nebr., July, 1890. Prof. T. A. Williams. Æcidia gregarious in oblong groups or patches 3–5^{mm} long and 2–3^{mm} wide, small ($\frac{1}{8}^{mm}$), sunk in the substance of the leaf, which is only slightly thickened, border narrow, erect, sublacerate. Spores subglobose or suboblong, more or less angular, smooth, 18–20μ in the longer diameter, orange yellow, approaching orange red.

ÆCIDIUM EUROTIÆ, n. s. On *Eurotia lanata*, Helena, Mont., Rev. F. D. Kelsey, June 1889, Com. F. W. Anderson. No. 514. *Æcidia hypophyllous*, arranged along each side of the midrib, short cylindrical, about $\frac{3}{4}^{mm}$ high and $\frac{1}{2}^{mm}$ broad, with a thin, suberect, sublacerated margin. Spores orange-yellow, subglobose, smooth, 15–20μ diameter.

UROMYCES SCABER, n. s. III. On leaves of some grass. Swift Creek, Custer County, Colo., October 1888. Cockerell, No. 62. Sori elliptical, bare, dark chestnut color, nearly black, $\frac{1}{2}$–1^{mm} long by $\frac{1}{2}$–$\frac{3}{4}^{mm}$ wide, pulvinate, gregarious or subconfluent. Spores globose 20–22μ or elliptical 22–25 by 20–22μ, densely echinate-scabrous, epispore scarcely thickened at the apex, pedicels subequal, hyaline, 40–50 by 4.

PUCCINIA ARABICOLA., n. s. On *Arabis* sp. Ottawa, Canada. Dr. J. Macoun, I and III.

I. Æcidia amphigenous, collected in patches or groups 2–4^{mm} across, hemispheric and closed at first, then open, small, shallow, margin slightly spreading and minutely denticulate. The spores having mostly disappeared from the rather scanty specimens, we can not now accurately describe them.

III. Sori amphigenous, scattered, small, black-brown, covered at first

by the lead-colored cuticle which is at length ruptured and forms a border around the margin. Spores elliptical, oblong or obovate, rounded and thickened above, smooth, constricted at the septum, 27–40 by 20–23μ on rather stout pedicels about as long as the spores. This is quite distinct from *P. thlaspeos*, Schubert, which has the sori paler and hypophyllous and has no æcidium. *P. aberrans* (N. A. F. 1834) is also different from this.

PUCCINIA ARALIÆ, n. s. On ginseng (*Panax trifolium*), Massachusetts, May, 1888, Miss C. H. Clark and M. C. Carter, III. Parts attacked more or less distorted. Sori caulicolous and foliicolous, minute, clustered in tufts 1–2^{mm} across, naked and of a dark-brown or nearly black color, not on any definite spots though the affected leaves turn more or less distinctly light yellow, the yellow area occupying a large part of the leaf. On some of the leaves the sori were placed opposite on each side of the leaf, but in this case those on the upper surface were smaller. Spores oblong or oblong-elliptical, with fine, granular contents, and granular-roughened, pale-brown epispore scarcely thickened at the apex, which is either regularly rounded and obtuse or capped with a small hyaline papilla. Scarcely constricted, 25–35 by 15–20μ on rather slender pedicels, about as long as or a little longer than the spore itself.

PUCCINIA XANTHIIFOLIA, n. s. (*P. compositarum*, Schlect. in N. A. F. 2252.) On leaves of *Iva xanthiifolia*, Manhattan, Kans., October, 1888. Dr. W. A. Kellerman. I and II not seen. III. Sori hypophyllous scattered, bare, black, ½–1^{mm} diameter, tuberculiform, compact. Teleutospores, elliptical or obovate-elliptical, smooth, rounded and thickened at the apex and mostly with a distinct papilla, constricted at the septum, deeply colored 35–45 by 18–23μ on long (70–80μ), slender, subpersistent pedicels. This is a very different thing from *P. compositarum*, for which, by some inexplicable error, it was distributed in N. A. F. *P. intermixta*, Pk., according to authentic specimens, is also very distinct from this.*

PUCCINIA CONSIMILIS, n. s. On leaves of *Sisymbrium linifolium*. Helena, Mont., May, 1889. Rev. F. D. Kelsey, No. 53. I and III. Hypophyllous. Acidia covering the greater part of the lower surface of the leaf. Shallow, soon open, margin sublacerate-toothed and narrowly reflexed. Æcidiospores pale yellow, subglobose or subovate, smooth, 20–23μ diameter.

III. Sori minute, ½^{mm} diameter, crowded but not confluent and like the æcidia occupying the greater part of the lower surface of the leaf, chestnut brown, closely surrounded by the ruptured epidermis, but naked above almost from the first. Teleutospores oblong-obovate, constricted, 25–42 by 18–22μ, thickened at the apex, with or without a papilla, which when present is either central or oblique, upper cell mostly broader and darker, lower cell also generally rounded at the base, pedicels as long as or longer than the spores.

*Puccinia bigeloviæ, E. and E., N. A. F. 2248, is on *Gutierrezia euthamia*, and may be only a form of *P. tanaceti*.

I and III occur together on the same leaf. The spermogonia were not observed. Possiby the *Æcidium* may be *Æcid. monoicum*, Pk., but the color of the spores is different and the cups are open almost from the first. The manner of growth is the same.

NOTES ON CERTAIN UREDINEÆ AND USTILAGINEÆ.

BY F. W. ANDERSON.

ÆCIDIUM CRASSUM, Pers., *Æcidium rhamni*, Pers., and *Æcidium pulcherrimum*, Ravenel, are identical, and are considered to be I of *Puccinia coronata*, Corda. In Sacc. Sylloge *Æcidium pulcherrimum* is retained, probably inadvertently, in specific rank, although it plainly belongs as above. No. 933 of de Thümen's Mycotheca Universalis, given as *Æcidium rhamni*, Persoon, is identical with Ravenel's specimen of *Æcidium pulcherrimum*.

NUMBER 1003 of Ellis's N. A. F. is *Æcidium ranunculacearum*, DC. But *b* of this number is *Æcidium ranunculi*, of Schweinitz. The most available, and as it appears to me fairly constant, points of distinction between these two species are as follows: *Æcidium ranunculacearum:* æcidia always in spots, preceded or accompanied by the spermogonia which are aggregated usually in the center of the æcidium spots. *Æcidium ranunculi*, Schweinitz: æcidia always effused, preceded or accompanied by the spermogonia, which are also effused and scattered, like the æcidia, indiscriminately over the surface of the leaf. Sometimes the leaf is thickly covered by the fungus and again it may bear only a cup here and there. The form of *Æcidium ranunculacearum* on *Ranunculus Cymbalaria*, so common at the West, at times shows some inclination to approach *Æcidium ranunculi* in its manner of growth, but after all never seems to lose entirely its specific characters.

ÆCIDIUM ALBUM, Clinton, in 26th Report of the New York State Museum for 1874 and *Æcidium porosum*, Peck, in Botanical Gazette, page 34, 1878, are identical. The two supposed species occur on the same host plants, and have constantly the same manner of growth from New York State to the Pacific Ocean. Herewith is given an amended description of this species: Spots none, cups few and scattered and almost superficial, or much crowded, in which case they appear to be deep-seated and give a porous appearance to the leaf surface; occupying a part or the whole of the lower surface of the leaves; frequently appearing on the stems also, in which situation they are hemispherical, or short-cylindrical, erumpent, and opening by a small, irregular, or roundish orifice. Spores from a bright orange color to almost colorless, very variable in this respect, subangular or roundish, oblong, oval or ovate, according to the free or crowded condition of the cups, 18 μ to 26 μ diameter. Saccardo in Sylloge, vol. 4, p. 787, says that *P. porosum* is distinct from *P. album*, but this can not be so.

Æcidium heliotropi, Tracy and Galloway, is the same as *Æcidium biforme*, Peck, which was published first and therefore has precedence.

Æcidium Palmeri, n. s.

On *Pentstemon virgatus*. Willow Spring, Ariz., June, 1890, collected by Dr. Edward Palmer. Com. Dr. J. N. Rose.

Spots more or less elongated, but little paler than rest of leaf; a little or not at all thickened. Pseudoperidia not deep seated, amphigenous; usually numerous and closely set, but not crowded together; when first bursting the epidermis, ovate and nearly white, or with the faintest possible purple tinge; soon becoming cylindric-clavate, with rounded or ovate apex; twice to at least four times as high as broad, straight or slightly curved; becoming flesh-colored fading to white above and at last becoming reddish-orange and sometimes opening by a small central orifice in the rounded apex, but more frequently opening by the fragile, white, broadly and irregularly ovate, to deeply cleft, acute, erect marginal lobes, which latterly fall away, often irregularly, exposing to view the orange-colored spores which fill the tubes. Spores roundish or irregularly polygonal to ovate or oblong and variously compressed; smooth, or very minutely roughened, epispore thickish; spore contents granular, with numerous yellow oil globules which escape freely under pressure; usually there are also two or three deep yellow and variously shaped nuclei. Spores orange colored, $16-26 \times 16-23\ \mu$.

This well marked Æcidium is very distinct from *Æcidium pentstemonis*, Schwein.

Puccinia cladophila, Peck, on *Stephanomeria minor*, in Botanical Gazette February, 1879, page 127, is the same as *Puccinia Harknessii*, Vize, on *Lygodesmia*, in Grevillia, vol. 7, page 11, September, 1878. The latter has been referred to *Puccinia hieracii*, (Schum.) Mart., (P. Dietel in Hedwigia, 1889, page 181); therefore *Puccinia cladophila* must also be referred to *Puccinia hieracii*, as that species is now understood.

Puccinia minussensis, de Thümen, No. 1430 of de Thümen's Mycotheca Universalis, is, like the preceding, *Puccinia hieracii*, (Schum.) Mart., and is very near the form on *Troximon glaucum* and the same as the form on *Lactuca pulchella* (syn. *Mulgedium pulchellum*), which is an American species nearly related to *Mulgedium Sibcrica*—the host of de Thümen's present species.

In Saccardo Sylloge, vol. 7, this *Puccinia* is left in specific rank, but the note after the description refers to its connection with *P. hieracii.*

Puccinia bigeloviæ, Ellis and Everhart, in N. A. F., No. 2248, has accidentally been named after a wrong host genus. The specimens distributed in North American Fungi are on *Guticrrezia euthamiæ*. The genus *Gutierrezia* is related to *Bigclovia* and it is likely that the fungus will yet be found on hosts in the latter genus, for which reason the authors of the species prefer to let the specific name go unchanged.

Western mycologists would do well, however, to make a series of cultures with the spores of *Puccinia bigeloviæ*, *Puccinia variolans*, Harkness and of *Puccinia variolans*, *var. caulicola*, Ellis and Everhart, to see

whether or no these are really distinct. At the same time cultures should be made with the spores of *Puccinia tanaceti*, DC.,* to which they seem to be too closely related, to see again whether they are distinct from that species, for, after a careful study of a large and varied supply of material and the accurate sketching of spores of each form, their validity is left much in doubt. Properly conducted cultures alone can positively decide the question.

PUCCINIA ELLISIANA, Thüm., in Bulletin of the Torrey Botanical Club, Vol. VI, p. 215, is now regarded by Mr. Ellis, Professor Farlow, and others to be the same as *Puccinia andropogonis*, Schweinitz, which has the right of priority.

PUCCINIA WINDSORIÆ, Schw., VAR AUSTRALIS, n. var. (*Puccinia Dochmia B. and C.*, North Pacific Expl. Exped., No. 131, and *Puccinia Palmeri*, Scribner in herb.) On grass leaves, apparently *Muhlenbergia*, Nicaragua, Central America; C. Wright coll. No. 131, N. P. Expedition; also on *Muhlenbergia* sp., Mexico; collected by Dr. Ed. Palmer, 1886.

Hypogenous or sparingly amphigenous. Sori small, rather more pulvinate than in the species, owing to the long spore pedicels, irregularly disposed, linear or oblong, more or less confluent, but rarely so in straight lines, the ruptured epidermis scarcely or not at all evident. Uredospores subglobose, obovate to oblong-ovate, brown, tegument somewhat thickened; epispore more or less distinctly echinulate, 16–25 by 20–26; teleutospores obovate, broadly elliptical to subglobose, the two last forms predominating; from pale to deep chestnut brown, usually darkest at the thickened vertex; little or not at all constricted at the septum, obtusely rounded or occasionally bluntly apiculate, 16–30 by 23–36 μ; pedicel pale brown to subhyaline, 75–125 μ long, by 3 to 6 μ thick at the base of the spore. Differs from the species in the very marked preponderance of the subglobose form of teleutospores and in the very long slender pedicels. A form almost the same as this occurs in the District of Columbia and in Florida. This form again is linked to the various forms of the species as they occur in different northern States. The description of the species itself should be a little more modified in order to embrace the usual, but not the glaring variations. It is also to be noted that in the variety as well as in the species the spores are often more or less obliquely to vertiseptate and the pedicels often to all appearances come from the side instead of from the base of the teleutospore.

In Saccardo's Sylloge, Vol. VII p. 770, are given brief descriptions of *Triphragmium clavellosum*, Berk., and *Triphragmium Thwaitesii*, B. & Br. The former occurs in America on *Aralia nudicaulis*, and is said (l. c.) to occur also in Ceylon on *Paratropa terebinthinacea*, *Hedera* and *Amygdaleæ* species. The latter is given for Ceylon as occurring on *Hedera Vahlii*, and the question is asked whether it is not the same as

*A careful study should also be made of *Puccinia tanaceti* DC. var. *Actinellæ* Webber on *Actinella acaulis*. If this is a good variety, then perhaps some others now included in the species, should be regarded in the same light. Anders.

T. clavellosum. I have not been able to secure Ceylon specimens referred to *T. clavellosum*, but it is quite likely that all such are referable to *T. Thwaitesii.* Of this latter I have secured an authentic specimen from Mr. J. B. Ellis, to whom it was sent by Dr. M. C. Cooke, of London, England. As *T. clavellosum* and *T. Thwaitesii* are related species it is easy to understand why confusion should arise concerning them, especially when we consider the meager published description in which spore measurements are entirely omitted. *T. Thwaitesii* is a quite distinct species from North American forms of *T. clavellosum*, and it is pretty safe to say that *T. clavellosum* is American and that *T. Thwaitesii* is Asiatic. I have, in the following, drawn up full descriptions of the two species. For the description of *T. clavellosum* I selected No. 844 of De Thümen's Mycotheca Universalis on *Aralia nudicaulis*, collected in the Adirondack Mountains, New York, by Ch. H. Peck. For the description of *T. Thwaitesii* I used the small specimen sent me by Mr. Ellis.

TRIPHRAGMIUM CLAVELLOSUM, Berk.

Epiphyllous; sori small, roundish-orbicular, or elliptical, surrounded by the ruptured epidermis and distinct, or as often confluent into apparently one large sorus, a quarter of an inch across, growing on more or less well defined spots. Uredospores not seen; teleutospores 30–40μ long by 16–30μ wide, globose to obovate or oblong in outline, the margin frequently not at all lobed, dark brown to almost black, epispore thickened and with numerous stout somewhat tapering appendages, the tips of which are emarginate, bifurcate, or even quadrate with four hyaline recurved lobes; pedicel at least as long as the spore, usually longer, 40–100 by 5–10μ thick at junction with base of spore, average size about 50μ long by 6μ thick, not much tapering and somewhat roughened. On *Aralia nudicaulis.*

TRIPHRAGMIUM THWAITESII, B. & Br.

Amphigenous, but most abundant on the upper surface of leaf; sori small, roundish, rarely confluent, growing on well defined irregular patches, which are blackish above and paler below. Uredospores (?) 28–35 by 30–50μ, oval to obovate, rather dark yellowish brown, epispore thickly beset with sharp awl-shaped spines about 3μ long; pedicel about length of spore, hyaline; teleutospores 30–60μ long by 27–59μ wide, globose to obovate outlined, more or less perfectly and uniformly three-lobed, often truncate at the apex, light brown to dark chestnut brown; epispore rather thick, appendages few, straight and tapering, expanding at the end into an emarginate and often distinctly bifurcated tip; pedicel about the length of the spore, seldom longer, slightly roughened, tapering to the slender and usually curved point, about 5μ thick at junction with base of the spore. It is possible that the uredospores described in the foregoing may belong to something else, as I only found two spores and they were mixed in with teleutospores. On *Hedera*, (?) Ceylon.

UROMYCES AMYGDALI, credited to Cooke in report on Insect and Fungous Pests, No. 1, by Henry Tryon, issued by the Department of Agriculture, Queensland, Australia, is doubtless *Uromyces amygdali*, Passer.; see the above report, page 97, Leaf Rust and Shedding of Foliage (*Uromyces amygdali*). At any rate this "*Uromyces*" turns out to be the uredo of *Puccinia pruni*, Pers. (See also Sacc. Syll. vol. VII, p. 648.) A series of excellent specimens has been received by the Division of Vegetable Pathology from two points in South Australia, collected on peach, plum, apricot, and almond leaves by Mr. F. S. Crawford and Mr. R. H. Simons. In some of these specimens the teleutospores have developed, and are present in great numbers in the same sori with the uredospores. They agree in every particular with specimens of *Puccinia pruni*, Pers. on peach and plum hosts in the United States.

UROMYCES SOPHORÆ, Peck, in Bulletin Torrey Bot. Club, Vol. XII, No. 4, p. 35, and *Uromyces hyalinus*, Peck, in Bot. Gaz. 1878, p. 34, are identical, and both again referable to the widely dispersed and consequently somewhat variable *Uromyces trifolii*, (Hedew.) Léveillé.

ENTYLOMA CRASTOPHILUM, Sacc., and ENTYLOMA IRREGULARIS, Johanson, are the same species, judging from the two specimens in the Herbarium of the Division of Vegetable Pathology—Krieger, Fungi Saxonici, 202; *Entyloma crastophilum*, Sacc. (Michelia I, p. 540, September 15, 1879), on *Agrostis?* W. Krieger leg; and Eriksson, Fungi Parasitici Scandinavici 259; *Entyloma irregularis*, Johanson, on *Poa annua*, C. J. Johanson coll. In the former specimen the spores are more angular than in the latter; the color is almost the same and the measurements of both are the same. As I make them, the measurements are 6–10 by 8–20μ, but rarely over 16μ long.

Saccardo's description was published first, hence *Entyloma crastophilum*, Sacc, has precedence.

USTILAGO SUCCISÆ, Magnus, *U. scabiosæ*, (Somer.) Wint. and *U. intermedia*, Schroeter, as given in Saccardo's Sylloge, vol. VII, p. 475 and 476, appear to be one species. They all occur in the anthers of *Scabiosa columbariæ* and *Scabiosa arvensis:* the name, *Knautia arvensis*, given in the Sylloge, is simply the old name of *Scabiosa arvensis. Ustilago intermedia* only differs from the other forms in its darker and more evidently reticulated spores, and does not seem to be more than a variety of *U. scabiosæ*, to which the other forms should be referred, and it is doubtful whether it deserves even varietal rank.

The notes now following were made directly from Berkeley & Curtis's type specimens in the Herbarium of the U. S. North Pacific Exploring Expedition under Commanders Ringgold and Rogers, 1853–'56. C. Wright collected the specimens.

PUCCINIA KAMTSCHATKÆ, Anders., n. s. On *Rosa* species, collected by C. Wright at Petropaulovski, Kamtschatka. Description

drawn up from specimen in the herbarium of the United States North Pacific Exploring Expedition under Commanders Ringgold and Rogers, 1853–'56. Specimens labeled "*Coleosporium pingue*, Lév.?"

Amphigenous, but most abundant on lower surface of leaf where the sori are confluent and irregularly effused; on the upper surface the sori are usually small, fewer, and less often confluent; surrounded more or less perfectly by the much lacerated and conspicuous epidermis: in the effused patches irregular lines of this epidermis stick up here and there, marking more or less plainly the boundary of several or many irregularly confluent sori. Sori rather large, variable in outline, not definitely arranged, becoming pulverulent; light snuff-colored. Uredospores globose, short ovate, obovate to oblong elliptical, smooth or slightly roughened, pale yellowish brown to light brown; epispore one-half to almost 3μ thick, but little or not at all thickened at the vertex, 13–27 by $13–30\mu$. Teleutospores oblong, ovate, oval to broadly elliptical, segments generally divided equally, usually not much constricted at the septum; vertex broadly rounded or occasionally narrowed, but not apiculate; epispore as thick as that of the uredospores, smooth or somewhat roughened, frequently a little thickened at the vertex, light brown, 13–37 by $20–54\mu$; pedicel stout, but fugaceous, yellowish hyaline, once to twice the length of the spore; paraphyses intermixed with the spores, pedicel-like, cylindrical, a little or not at all swollen at the rounded apex.

The general appearance of this Puccinia *en masse* is that of the uredo stage of *Phragmidium subcorticum*, (Schrank). It thickens and changes the shape of the leaf just as that does, and without a microscopic examination would be passed over as *Phragmidium subcorticum II*, turned snuff brown. *Coleosporium pingue*, Léveillé, is merely the uredo of *Phragmidium subcorticum.* It is more than likely that *Puccinia Kamtschatkæ* will be found by careful seekers on various *Rosa* forms in the northern Rocky Mountains and along the northwestern coast of America.

Puccinia triarticulata, B. & C. Herbarium of the North Pacific Exploring Expedition, No. 130. Collected by C. Wright on *Elymus mollis*, Arakamtchetchene Island, Behring Straits. The original description is not complete, lacking spore measurements and other notes of value. We may expect to find this species in Alaska and along the northwestern coast of America generally. The following more complete description has been drawn up from a type specimen: Sori linear to narrowly oblong, buried in the tissue, but forming a pustule on the surface of the host, finally bursting the epidermis and presenting a level dark-brown surface. Uredospores? Teleutospores two to three septate, 60–100 by $12–24\mu$; pale brown, elongated, oblong, narrowly cuneate or cylindric-clavate, with an ovate, or rounded, or more or less obliquely truncate apex, constricted at the septa or not; epispore thin, smooth, vertex frequently thickened; pedicel short, stout rather dark reddish brown,

strongly contrasting with the pale color of the spore, 5–9 by 5–14μ, and rather firmly attached to the dense parenchymatous stroma, which, like the pedicel, is reddish brown. This peculiar species is rather a doubtful Puccinia.

PUCCINIA SEPULTA, B. & C. Herbarium North Pacific Expedition, No. 131, on leaves of *Ficus?* Nicaragua, Central America. C. Wright, collector.

Hypophyllous, spots orbicular, brown on both sides, but more definitely outlined on the upper; bullate above, concave beneath; sori congested in a uniform mass and more or less perfectly covered by the host hairs adherent to the epidermal fragments protruding from between the crowded sori. Uredospores? Teleutospores 23–75 by 13–27, brown and smooth, extremely variable in size and shape, narrowly oblong and much elongated, or broadly clavate, obtusely elliptical, obovate, cuneate to broadly subturbinate; constricted at the septum, or not; apex subtruncate, or variously rounded, sometimes narrowed, usually thickened, lower segment quite often narrow and distinguishable only from the broad and often somewhat swollen pedicel by the septum at base, where it is often constricted; pedicel narrow or broad, frequently swollen above, but constricted at junction with the spore, less than twice the length of the spore, brown, or dilute brown, often coming from one corner of spore base instead of the center. Occasionally three-celled spores are seen, and even two perfectly formed spores normal in size are found, the base of the upper joined closely to the apex of the lower by about the width usually occupied by the pedicel; or, two spores may be joined laterally by a small surface of the upper segments, the lateral spore having no pedicel of its own, and again, the upper segment also of an individual spore is sometimes vertically septate, showing an inclination towards *Triphragmium*.

UREDO BAUHINIÆ, B. & C. Fungi North Pacific Expedition, No 138. C. Wright, coll., on *Bauhinia* sp.

Amphigenous, but more sparing above. Spots small, yellowish, or quite obsolete. Sori small, roundish, or orbicular, scattered, rarely confluent, dark reddish brown, the ruptured epidermis more or less evident; spores globose, broadly obovate or broadly and obtusely elliptical, echinulate, reddish fuscous, 26–30 by 26–33μ, epispore 3–5μ thick; pedicel 20–30μ long, hyaline and fragile.

INDEX TO NORTH AMERICAN MYCOLOGICAL LITERATURE.

By David G. Fairchild.

113. Arthur, J. C. **Treatment for smut in wheat.** Bull. 32, Vol. II, July, 1890, pp. 1–10, Indiana Agr. Exp. Sta., La Fayette, Ind. Gives tests of vitality of seed wheat after treatment with Jensen hot-water method for smut. Finds 66° C. as maximum temperature at which the vitality of the seeds is retained and immersion for five minutes in water at a temperature of 57° C. to give the largest percentage of uninjured grains, considering high temperature. Recommends lengthening time of immersion with lowering of temperature and vice versa. No test of the method as to preventive power against smut. Gives percentages of stalks smutted with loose smut in counts of two varieties as 11.58 per cent. and 24.41 per cent.

114. ——— and Bolley, H. L. **The specific germ of the carnation disease.** Bot. Gaz., September, 1890, Vol. XV, No. 9, p. 231 Abstract of paper read by title before A. A. A. S. Botanical Section, August 19, 1890. Indicates demonstration of bacterial disease.

115. Atkinson, Geo. F. **A new Ramularia on cotton** (with figures). Bot. Gaz., Vol. XV., No. 7, July 22, 1890, p. 166. Describes and figures as new, *Ramularia areola*, n. s. on cotton, which differs from *R. serotina* and *R. virgaureæ* in having stouter conidia and hyphæ.

116. Bailey, L. H. **Report on the condition of fruit-growing in western New York.** Bull XIX, August, 1890, Cornell Agr. Exp. Sta., Ithaca, N. Y., pp. 45–58 (with figs) Notices as particularly abundant in 1890: *Fusicladium dendriticum*, (Wallr.) Fckl. on apples; *F. pyrinum*, (Lib.) Fckl. on pears. Quince and pear leaf blight, *Entomosporium maculatum*, Lév. *Taphrina deformans*, *Glœosporium venetum* or *G. necator*, *Sphærella fragariæ*, Sacc. and various grape diseases. Gives latest ideas in treatment of various maladies.

117. Beadle, D. W. **The apple scab.** Horticultural Art Journal, Rochester, N. Y. October, 1890, Vol. V, part 10, p. 82. Sums up work of L. R. Taft in Mich., Agr. Exp. Sta. in 1889 (*see* 104).

118. Bessey, Chas. E. **The completion of Saccardo's Sylloge Fungorum.** American Naturalist, July, 1890, XXIV, 283, p. 675. Reviews and commends the work, giving synopsis of orders with total numbers of species described, 31,927 in all.

119. Bolley, H. L. **Potato scab, a bacterial disease.** Bot. Gaz., September, 1890, Vol. XV, No. 9, p. 234. Abstract of paper read before A. A. A. S. Botanical Club, August 19, 1890. Gives histology and biology of disease, with outline of infection experiments performed.

120. ———. **Potato scab, a bacterial disease.** Agricultural Science, La Fayette, Ind., September 1890. Vol. IV, No. 9, pp. 243–256. Discusses at some length the theories regarding the nature and cause of the disease, viz., mechanical irritation, insect agencies, chemical erosion, excess of moisture, action of fungi. Follows with a record of original investigation, noting work of Dr. Brunchorst, of Sweden, who describes *Spongospora solani* as cause of the malady. Records results of various infection tests, inoculating young tubers in various ways with various species of bacteria found present in the diseased areas. Gives conclusive experiments to determine that disease is transmitted by the practice of planting scabby seed potatoes.

121. ——— *Ibid.* Oct. No. 10. pp. 277–287. Continues description by treating of separation and culture methods; infection or inoculation of growing tubers; characteristics of development upon artificial culture media; drop cultures; stick cultures; streak cultures; cultures on sliced cooked potatoes; effect of

121. BOLLEY, H. L.—Continued.
gases and of different degrees of temperature upon the development of the bacterium; name of bacterium, relation to the host, mode of attack. Gives plates III and IV with bibliography of disease.

122. BRITTON, N. L., AND HOLLICK, ARTHUR. **List of Staten Island fungi in the collection of the Association.** Proc. Nat. Sci. Ass. of Staten Island. Special, No. 11, August 1890. *Basidiomycetes* 37, *Ascomycetes* 3, *Hypomycetes* 1. *Myxomycetes* 1. Determinations by J. B. Ellis.

123. CHESTER, F. D. **Diseases of the vine.** Bull. X, Delaware State Agricultural Exp. Sta., Newark, Del. 1890, pp. 8–32. Gives results of experiments at Smyrna with black-rot. Used Bordeaux mixture and saved 99.5 per cent. fruit in comparison with 84 per cent. unsprayed. Records use of ammoniated copper carbonate, copper carbonate and ammonium carbonate mixture, precipitated copper carbonate, and Bordeaux mixture against anthracnose, deciding the precipitated copper carbonate and Bordeaux mixtures as wholly effectual. Reports use of above copper mixtures with modified eau celeste and mixture No. 5, U. S. Dept. of Agr. against black-rot near Newark, also of study, by periodical bagging, of progress of disease in vineyards. Gives directions for preparing fungicides, prices of chemicals, and recommendations as to spraying apparatus.

124. ELLIS, J. B., AND EVERHART, B. M. **New North American Fungi.** Reprint from proceedings of Academy of Natural Sciences of Philadelphia, July 29, 1890. Describes as new 100 species, mostly saprophytic, as follows: *Typhula subfasciculata*, *Stereum atrorubrum*, *Hymenochæte rugispora*, *Asterina rubicola*, *A. bignoniæ*, *Chaetomium pusillum*, *Myriococcum consimile*, *Calosphæria alnicola*, *C. microsperma*, *Cœlosphæria corticata*, *Diaporthe nivosa*, Ell. & Holw., *Valsa floriformis*, *V. glandulosa*, Cke., *V.* (*Eutypella*) *canodisca*, Ell. & Holw., *Pseudovalsa stylospora*, *Thyridaria fraxini*, *Cryptovalsa sparsa*, *Diatrype Macounii*, *D. Hochelagæ*, *Diatrypella vitis*, *D. Demetrionis*, *Ceratostomella mali*, *Ceratostoma juniperinum*, *C. parasiticum*, *C. conicum*, *Rosellinia albolanata*, *R. glandiformis*, *R. parasitica*, *R. Kellermanni*, *R. Langloisii*, *Anthostoma Ontariensis*, *Anthostomella ludoviciana*, Ell. & Lang., *Hypoxylon albocinctum*, *Poronia leporina*, *Physalospora zeicola*, *P. conica*, *P. pandani*, *Læstadia orientalis*, *L. apocyni*, *Sphærella conigena**, *S. spinicola*, *S. ciliata*, *S. angelicæ*, *S. maeluræ*, *S. polifolia*, *Didymella Canadensis*, *D. cornuta*, *D. andropogonis*, *D. mali*, *Venturia parasitica*, *V. sabalicola*, *Diaporthe Columbiensis*, *D.* (*Euporthe*) *leucosarca*, *D. corinigera*, *D. comptoniæ*, *D. Americana*, Speg., *D. megalospora*, *Didymosphæria andropogonis*, E. & Lang., *Melanconis salicina*, *Valsaria salicina*, *Leptosphæria macluræ*, *L. steironematis*, *L. brunellæ*, *L. folliculata*, *Metasphæria rubida*, *Pleospora diaportheoides*, *P. hyalospora*, *Pyrenophora Zabriskieana*, *Fenestella amorpha*, *Ophiobolus trichisporus*, *O. medusæ*, *Melanomma Commonsii*, *M. tetonensis*, *M. parasiticum*, *Winteria tuberculifera*, *Cucurbitaria Kelseyi*, *C. fraxini*, *C. setosa*, *Teichospora mammoides*, *T. mycogena*, *T. umbonata*, *T. papillosa*, *T. megastega*, *T. Helenæ*, *T. Kansensis*, *Nectria diplocarpa*, *Hypocrea pallida*, *H. melaleuca*, *Calonectria Dearnessii*, *Thyronectria chrysogramma*, *Chilonectria cringera*, *Nectria sambuci*, *N. athroa*, *N. mammoidea*, Phil. & Plow., *N. pithoides*, *N. sulphurata*, *Homostegia Kelseyi*, *Dothidea bigeloviæ*, *Plowrightia staphylina*, *P. symphoricarpi*, *Curreya shepherdiæ*.

125. FAIRMAN, C. E. **Contributions to the mycology of western New York.** I. The fungi of western New York. Extract, Proc. Rochester Academy of Sciences, Vol. I, August, 1890, pp. 43–53, with plates 3 and 4. Notes the discovery in Orleans County of 425 species variously distributed among the different orders, with remarks on more common species. Remarks: *Septoria stellariæ*, R. & D., on

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* This is changed to *S. Andersoni*, as there is already an *S. conigena*, Pk.

125. FAIRMAN, C. E.—Continued.
Stellaria media. Phyllosticta cirsii, Desm., on *Cnicus arvensis, Corticium lividocœruleum*, Karst., *Tapesia rosœ* (Pers.) as new to this country. Appends list of 30 species or varieties, 17 of which are new. Those described as new are as follows: *Didymosphœria accedens*, Sacc. (with fig.) *Anthostomella eructans*, E. & E. (with fig.) *Lophiostoma rhopaloides*, Sacc. var *pluriseptata*, n. var., *Pseudovalsa Fairmani*, E. & E., *Vermicularia solanoica* n. s. on *Solanum dulcamara, Phoma Weldiana* n. s. on *Euonymus atropurpureus, Phoma albovestita*, n. s., *Phoma Lyndonvillensis*, n. s. on *Malva rotundifolia*, (with fig.) *Phoma rudbeckiœ*, n. s. on *Rudbeckia laciniata, Diplodia maura*, C. & E., var. *Americana*, Ell. on *Gyrus americana, Morthiera Thuemenii*, Cooke, var. *Sphœrocysta* Pk. on *Crategus, Sphœropsis lappœ*, E. & E. on *Lappa major, Sporidesmium toruloides*, E. & E. on *Cornus, Mucor tœniœ*, n. s. on *Tœnia solium* (with fig.) *Helotium fumosum*, E. & E. on *Leonurus cardiaca* and *Lappa major, Camarosporium acerinum*, E. &. E. on *Acer* limbs, *Tubulina cylindrica*, Bull., var. *acuta*, Peck.

126. FARLOW, W. G., AND SEYMOUR, A. B. **A provisional host index of the fungi of the United States, Part II.** Gamopetalæ-Apetalæ, Cambridge, Mass., September, 1890; pp. 53-133–Quarto. Part I, issued in 1888. Gives in most convenient form index of all published host plants, together with partial synonymy of different species of fungi. Myxomycetes are omitted from the list except when of more than usual interest. In cases of very common fungi occurring on many species of host plants the authors do not include all hosts, unless the fungus is of economic importance.

127. FORSTER, EDWARD J. **The Study of mushrooms.** Boston Medical and Surgical Journal, October 2, 1890. Reprinted leaflet. Gives, in reply to inquiries, a list of 14 works upon *Hymenomycetes* with special reference to esculent species. No reference made to periodical literature.

128. ———. **Mushrooms and mushroom poisoning.** Read at Ann. Meeting Mass. Med. Soc., June 11, 1890, Boston City Hospital. Pamphlet. Distinguishes, precisely, edible and poisonous forms (with figures), giving minute instructions as to habitats; adds a table of statistics of 44 cases of mushroom poisoning; concludes all known fatal cases caused by eating *Amanitœ;* gives as universal antidote atropia in full doses, $\frac{1}{8}$ of a grain, preceded by usual emetics and purgatives.

129. GALLOWAY, B. T. **New fields, the past and the future in the world of fungi.** American Garden, September 24, 1890; pp. 573-577. Times Building, New York. Gives in popular language a short history of Economic Mycology, with account of the extension in this country of the use of fungicides and fungicidal apparatus. Figures examples of treated and untreated plants, together with a new knapsack pump.

130. ———. **Some recent observations on black-rot of the grape.** Botanical Gazette, October 28, 1890, Vol. XV, No. 10, pp. 255-259. Records series of four experiments to establish connection of *Phyllosticta labruscœ*, Thüm., *P. ampelopsidis*, E. & M., and *Lœstadia Bidwellii*, (Ell.) V. & R. States results of 200 inoculations of grape berries with leaf pycnidiospores and 200 inoculations of leaves with berry pycnidiospores as purely negative. Fifty inoculations of berries with berry pycnidiospores also produced no result; but both inoculations of *Ampelopsis* and *Vitis* leaves with ascospores from berries produced characteristic spots and pycnidia. Gives account of methods employed.

131. ———. **Preliminary notes on a new and destructive oat disease.** Botanical Gazette, September, 1890, Vol. XV, No. 9, p. 228. Abstract of paper read before Botanical Section A. A. A. S., August 19, 1890. Notes discovery of cause of the disease as a micro-organism, grown in various cultures.

132. ———. **Observations on the life-history of Uncinula spiralis.** *Ibid.* Abstract of paper given before Botanical Section A. A. A. S. Gives life-history and methods used to establish relationship between various forms.

133. GOLDEN, KATHERINE E. **Fermentation of bread.** Botanical Gazette, August 25, 1890, Vol. XV, No. 8, p. 204. Gives summary of previous work on the subject, with original investigation with plate culture methods. Finds in case examined *Saccharomyces cerevisiæ* and *Bacillus subtilis* (?) present in yeast, proving both to be able to raise bread sponges. Concludes yeast to be more effective in the production of gas in the sponges and Bacteria in the fluid cultures. Decides both to work together in producing the bread fermentation.

134. HALSTED, B. D. **Peronospora rubi, Rabenh., in America.** Botanical Gazette, Vol. XV, No. 7, July 22, 1890, p. 179. Notices first appearance of the fungus on cultivated raspberry in this country.

135. ———. **Some fungous diseases of the spinach.** Bull. 70, July 26, 1890. New Jersey Agr'l College Expt. Sta., New Brunswick, N. J., pp. 15 (with 21 figs.). Gives popularized descriptions with figures of *Peronospora effusa*, Rabenh., *Colletotrichium spinaceæ*, Ell. & Hals., *Phyllosticta chenopodii*, Sacc., *Entyloma Ellisii*, Hals., *Cladosporium macrocarpum*, Drew. Points out difficulty of treatment for diseases on account of nature of use to which spinach is put and recommends clean culture, destruction of weed host plants, and cautious use of chemical fungicides, also mixture of lime and sulphur with soil.

136. ———. **A dangerous enemy to the radish.** Garden and Forest, November 5, 1890, Vol. III, No. 141, p. 541. New York City. Notes great injury to crop by a species of *Plasmodiophora*, thought to be identical or nearly related to that causing club-root of cabbage.

137. ———. **The rot among late potatoes.** Garden and Forest, November 12, 1890. No. 142, Vol. III, p. 551. Shows danger from *P. infestans* in late planting of potato

138. ———. **Effect of forest management on orchards.** Garden and Forest, October 8, 1890, Vol. III, No. 137, p. 487. Discusses injurious proximity of cedar trees bearing the fungus *Gymnosporangium*, citing marked case of injury. Notes black-knot of plum and blackberry rust in connection.

139. ———. **The egg-plant blight.** Garden and Forest, September 17, 1890, Vol. III, No. 134, p. 457. Notes destructive occurrence of *Phyllosticta hortorum*, Speg. upon leaves and fruit of egg-plant. Remarks its especially destructive nature in Gloucester County, N. J. Thinks it can be checked by the copper mixtures.

140. ———. **The celery blight.** Garden and Forest, October 1, 1890, Vol. III, No. 136, p. 141. Notes destructive abundance of *Cercospora apii* in Mercer County, N. J., its habit of thriving in dry weather; suggests use of ammoniacal copper carbonate and shading with lath as remedies.

141. ———. **Cedar galls and rust on apple leaves.** Cult. and Country Gentleman, Albany, N. Y., October 2, 1890, Vol. LV, No. 1966, p. 780. Notes destructive abundance of apple rust (*Ræstelia*) in orchards in Mercer County, N. J. Explained by proximity of cedar trees affected by cedar galls (*Gymnosporangium*).

142. ———. **Sweet potato rot in New Jersey.** The soil rot. Cult. and Country Gentleman, October 9, 1890, p. 796, Vol. LV, No. 1967. Describes the fungus as living in the soil from year to year and records cases of spread from diseased fields to healthy ones.

143. ———. **Smut in grain.** Cult. and Country Gentleman, Albany, N. Y., March 6, 1890, Vol. LV, No. 1936, p. 184. Gives description of Jensen's hot-water treatment in prevention, referring to work in Kansas by Kellerman and Swingle (see No. 156).

144. ———. **Sundry sweet potato rots.** Cult. and Country Gentleman, April 10, 1890, Vol. LV, No. 1941, p. 286. Notes five kinds of rot of sweet potatoes with suggestions as to treatment.

145. ———. **Canada thistle rusting out.** American Agriculturist, August, 1890, Vol. XLIX, No. 8, p. 402. Notes destruction of Canada thistle about New Brunswick, N. J., through the attacks of the rust (*Puccinia suaveolens*, (*Pers.*) *Wint.*).

146. HARKNESS, H. W. **Dangerous fungi.** Zoë, San Francisco, Cal., July, 1890, Vol. I, No. 5, p. 150. Gives localities in California where *Peronospora viticola, Plowrightia morbosa, Taphrina (Exoascus) pruni* are destructive. Notes freedom of *Prunus ilicifolia* from disease.

147. ———. **Fungi collected by T. S. Brandegee in Lower California.** Proc. Cal. Acad. Sci., Second Series, Vol. II, 1889, December 20, 1889 (distributed 1890). Names 14 species, describing as new, *Puccinia ornata*, Hark. with Plate XII on *Tacoma stans*, Commondu. Related to *P. medusæ*, Speg., differing in size.

148. HARVEY, F. L. **The potato rot** (*P. infestans*). Ann. Rep. Maine Ag. Exp. Sta., 1889 (1890), Bangor, Me., pp. 173, 181 (with plate by C. H. Fernald figuring so-called oospores). Gives origin, history, primary causes, secondary causes, conditions of growth, description, life-history, and remedies, direct and preventive.

149. ———. **Apple scab.** *Ibid.*, pp. 182, 184 (with plate copied from U. S. Dept. of Ag. Report, 1887). Reviews work done by Taft in Michigan and Goff in Wisconsin (see 42 and 104).

150. HICKMAN, J. F. **Smut in wheat.** Bull. Ohio Ag. Exp. Sta., Second Series, Vol. III, No. 6, July, 1890, p. 205. Reports unusual abundance of stinking smut, with table of percentages of smut estimated in field, and counts of the number of smutted grains in 1,000 grains after threshing, also result of use of too strong solution of copper sulphate.

151. HOWELL, MISS J. K. **Trimorphism in Uromyces trifolii.** Bot. Gaz., September, 1890, Vol. XV, No. 9, p. 228. Abstract of paper read before A. A. A. S. Botanical Section, August 19, 1890. Records cultures made to determine connection of the three forms. Finds æcidiospores germinating throughout the winter. Proves the relationship beyond question.

152. HUMPHREY, J. E. **Mildews.** Trans. Mass. Hort. Soc. 1889, Pt. I, 1890, Boston, Mass., pp. 40, 52. Gives statement of object of new department of vegetable physiology connected with station. Describes in clear popular language the growth, life-history, and means of combating the powdery mildews (*Peronosporaceæ*). Notes *Pythophthora infestans*, DBy., *Peronospora viticola*, B. & C., *P. gangliformis*, Tul., *P. graminicola*, Sacc. on Hungarian grass or millet, *P. Schleideniana*, Ung.

153 KEAN, A. L. **On the nature of certain plant diseases.** Bot. Gaz., Vol. XV, No. 7, July 22, 1890, p. 171. Notices peculiar habits of *Rhizopus nigricans* with reference to parasitism on sweet potatoes. Claims the discovery of an active "ferment," excreted by fungal hyphæ, which precedes the growth of the hyphæ, breaking down the tissue. Mentions alcoholic precipitate as poisonous to healthy tissue. Thinks such fungi not truly parasitic, but dependent upon chemical agents for their disease causing power. Refers to H. M. Ward's lily disease in Ann. Bot., May, 1889.

154. KELLERMAN, W. A. **Prevention of smut in cereals.** Agricultural Science, Vol. IV, No. 4, April, 1890, pp. 99–101. Lafayette, Ind., gives account of Jensen hot-water method of prevention with modification found necessary for barley, consisting in soaking the seed eight hours in cold water before plunging into hot water.

155. ———. **Prevention of stinking smut in wheat.** Industrialist, Manhattan, Kans., October 4, 1890, Vol. XVI, No. 3, p. 9. Reproduction of description of Jensen hot-water method to prevent smut contained in Bull. 12, Bot. Department, Kans., Ag. Coll. Exp. Sta., August, 1890 (see No. 157).

156. ——— AND SWINGLE, W. T. **Report on the loose smuts of cereals.** Report of Botanical Department. Extract from Annual Rep. Kans. State Ag. Exp. Sta., Manhattan, Kans., 1890, pp. 213–288, Plates I to IX. Gives most thorough treatment of the whole subject, including synonomy of loose smuts; splitting up the hitherto well-known *Ustilago segetum*, (Bull.) Ditm. or *Ustil-*

156. KELLERMAN, W. A., AND SWINGLE, W. T.—Continued
ago carbo, (DC.) Tul., indiscriminately called, into *Ustilago avenæ*, (Pers.) Jensen (oat smut); *Ustilago tritici*, (Pers.) Jensen, (loose smut of wheat); *Ustilago hordei*, (Pers.) Kellerman and Swingle (covered barley smut); *Ustilago nuda*, (Jensen) Kellerman and Swingle (naked barley smut); of *Ustilago avenæ* (Plates I, IV, V), gives history, synonomy, injuries to host plant, different varieties attacked, amount of damage (in general over 8 per cent., at Manhattan, Kans., 10 per cent.), geographical distribution, botanic and microscopic characters of the smut, germination of spores in water, germination of spores in nutrient solutions, infection of the host plant (historical), methods of treatment (mechanical, chemical, and physical, with description of Jensen's hot-water method and report of successful experiment with same): notes a new form of oat smut (*Ustilago avenæ* var. *levis*, Kell. and Swingle.) Of *Ustilago tritici*, (Pers.) Jensen (Plates II and VI), history, synonomy, injuries to host plant, geographical distribution, characters of the smut, germination of spores in water, germination of spores in nutrient solutions, prevention. Of *Ustilago hordei*, (Pers.) Kell. and Swing. (Plates II and VII), gives history, synonomy, nature of injuries to host plant, geographical distribution, characters of the smut, germination in water, germination in nutrient solution, manner of infection of host plant, methods of prevention. Of *Ustilago nuda*, (Jensen) Kell. and Swing., gives history, synonomy, injuries to host plant, geographical distribution, botanical and microscopic characters of the smut, germination of spores in water, germination of spores in nutrient solution, manner of entering the host plant, methods of prevention. Natural enemies of the smut (Plate IX), *Fusarium ustilaginis*, Kell. and Swing. *Macrosporium utile*, Kell. and Swing., *Bacterium* (?) sp. Smut-eating beetles, *Phalacrus politus* or *penicillatus* and *Brachytarsus variegatus*, Say. Gives note also on stinking smut of wheat (Plate III), caused by *Tilletia fœtens*, (B. and C.) Trel. and *Tilletia tritici*, (Bjerk.) Wint.

157. ———. **Preliminary experiments with fungicides for stinking smut of wheat.** Bull. No. 12, August, 1890. Kansas State Agr. Exp. Sta., Manhattan, Kans., pp. 27–51 with Plate I. Give as introduction, amount of damage, cause of disease, growth of characters of parasite, germination of spores, comparison of loose and stinking smut, mode of infection. Report on use of 51 different treatments for disease, deciding Jensen hot-water method most successful (see p. 117 this number of the JOURNAL.)

158. LONG, E. A. **Plum-leaf blight or shot-hole fungus.** Pop. Gardening, Buffalo, N. Y., Vol. V, No. 12, p. 249, 1890. Notes *Septoria cerasina*, Pk. (with sketch). Recommends burning dead leaves, and spraying early in season with Bordeaux mixture.

159. MCMILLAN, CONWAY. **Note on a new species of Actinoceps, B. and Br.** American Naturalist, August, 1890. Vol. XXIV, No. 284, p. 777–779. Describes as new *Actinoceps Besseyi*, McM. found on putrid orange skin among bacteria, thinking difference in size of stipe and head sufficient to separate it from *Actinoceps Thwaitesii*, B. &. Br.

160. MEEHAN, THOMAS. **Fairy rings.** Cult. and Country Gentleman, Albany, N. Y., January 16, 1890, Vol. LV, No. 1929, p. 48. Gives history and description, referring cause to species of *Agaricini*, varying with different cases. Divides rings into two classes: one with dead grass in center, other with ring only.

161. PAMMELL, L. H. **Treatment of fungous diseases.** Orange Judd Farmer, Chicago, Ill., November 1, 1890, Vol. VIII, No. 18, p. 277, ½ column. Notices shortly history of growth of this line of mycology.

162. ———. **Pear-leaf blight.** Orange Judd Farmer, Chicago, Ill., October 25, 1890, p. 261, Vol. VIII, No. 17. Gives extended notice of work of U. S. Dept. of Agr. against *Entomosporium maculatum*, Lév. in season 1889–1890 (see No. 11).

163. ———. **Pear or fire blight.** Orange Judd Farmer, Chicago, Ill. Vol. VIII, No. 13, September 27, 1890, p. 197. Gives short history with observations and recommendations of treatment.

164. ——— **Strawberry-leaf blight.** Orange Judd Farmer, Chicago, Ill., August 23, 1890, Vol. VIII, No. 8, p. 115 (with figures). Gives popular exposition of disease caused by *Sphærella fragariæ* Sacc., methods which have been used and recommended in its treatment.

165. ——— **Strawberry-leaf blight.** Iowa State Register, Des Moines, Oct. 17, 1890, p. 7. Gives popular description with recommendations for treatment, viz, garden hygiene and fungicides, making reference to work of U. S. Dept. of Agr.

166. PANTON, J. HOYES. **Black-knot on plums.** Bull. LII., January 16, 1890. Guelph, Ontario. Describes the fungus popularly. Recommends destruction of diseased parts and removal of wild choke-cherry trees adjacent to orchards.

167. PECK, CHARLES H. **A. Plants added to the herbarium. C. Plants not before reported. D. Remarks and observations. E. New York species of Armillaria. F. Communication by P. H. Dudley in reference to decay of railroad ties.** Ann. Rep. State Botanist of New York, from 43 Rep. of N. Y. State Museum of Nat. History, Albany, N. Y., March 21, 1890; pp. 1–54, with 4 plates. Gives the usual list of additions to the herbarium, with notes on destructiveness of *Monilia fructigena*, *Glœosporium ribis*, *G. lagenarium*, *G. Lindemuthianum*, *Rhopalomyces cucurbitarum*, *Peronospora viticola*, *Phytophthora infestans* (with trials of Bordeaux and methods of deep planting to prevent the disease). Notes disease of oats in St. Lawrence County, thought to be due to *Fusicladium destruens*, n. s. and describes forty-two new species of fungi with numerous valuable notes upon old and new species, adding a short monograph of the eight known New York species of *Armillaria*. Appends interesting letter from P. H. Dudley upon fungi attacking railroad ties and other timbers. The species described as new are as follows: *Tricholoma grave* (with figs.), *Clitocybe multiceps*, *Coprinus brassicæ* (with figs.), *Cortinarius* (*Phlegmacium*) *glutinosus*, *C.* (*Inoloma*) *annulatus* (with figs.), *C.* (*Dermocybe*) *luteus*, *C.* (*Telamonia*) *paludosus*, *Lactarius subinsulsus*, *L. mutabilis* (with figs.), *Russula brevipes* (with figs.), *Marasmius albiceps* (with figs.), *Poria aurea*, *Irpex rimosus*, *Corticium mutatum*, *C. subaurantiacum*, *C. basale*, *Peniophora unicolor*, *Clavaria similis*, *Comatricha longa* (with figs.), *C. subcæspitosa* (with figs.), *Phyllosticta bicolor* on *Rubus odoratus*, *P. prini* on *Ilex verticillata*, *P. silenes* on *S. antirrhina*, *Phoma allantella* on *Quercus rubra*, *Plasmopara viburni* on *Viburnum dentatum*, *Sporotrichum cinereum*, *Coniosporium polytrichi*, *Stachybotrys elongata* (with figs.), *Dematium parasiticum*, *Fusicladium destruens* (with figs.) on *Avena sativa*, *Macrosporium polytrichi*, *Tubercularia carpogena*, *Fusarium sclerodermatis*, *Glœosporium leptospermum*, UNDERWOODIA gen. nov., *U. columnaris* (with figs.), *Helotium mycetophilum*, *Hæmatomyces faginea* (with figs.), *Eutypella longirostris* (with figs.), *Lepiota farinosa*, *Pholiota æruginosa*, *Phellorina Californica*.

168. PORTER, MISS E. **Notes on spore discharge of ascomycetes.** Bull. Torrey Bot. Club., New York, September, 1890, Vol. XVII, No. 9, p. 238. Abstract of paper read August 26, 1890, before Botanical Club of A. A. A. S., Indianapolis, Ind. Gives observations of this process in *Pleospora*.

169. REX. GEORGE A. **A remarkable variation of Stemonitis Bauerlinii, Mass.** Proc. Nat. Sci. Ass'n, Staten Island, No. 11, August, 1890. Notes curious case of reversion of an extremely variant form to the original Stemonitis type. Records the variation as *S. Bauerlinii* var. *fenestrata*, Rex.

170. RUSSELL, H. L. **Penicillium and corrosive sublimate.** Bot. Gaz., August 25, 1890. Vol. XV, No. 8, p. 211. Notes Dr. Coulter's remark in March number of Gazette, giving plate-culture tests with percentage solutions of mercuric chloride. Finds the fungus no more able to stand presence of germicide than other species, when the latter is thoroughly mixed in the media.

171. SCRIBNER, F. L. **Pear scab.** Orchard and Garden, Little Silver, N. J., August, 1890, Vol. XII, No. 8 (with figs.). Gives description of disease caused by *F. dendriticum*, (Wallr.) Fckl., considering the latter synonymous with *F. pyrinum*, (Lib.) Fckl. Shows necessity of early spraying. Recommends ammoniacal copper carbonate.

172. ——— **The powdery mildew of the rose.** Ibid, p. 144 (with figs.). Describes disease carefully, giving for remedies sulphur and potassium sulphide.

173. SOUTHWORTH, MISS E. A. **A new hollyhock disease.** Bull Torr. Bot. Club, Vol. XVII. No. 9, September, 1890, p. 235, N. Y. Notice of paper read by B. T. Galloway before Botanical Club A. A. A. S., Indianapolis, Ind., August, 1890. Describes diseases as caused by *Colletotrichium althææ*, n. s.

174. WEED, C. M. **The potato blight.** Am. Agriculturist, New York. Vol. XLIX, No. 7, p. 360. Notes successful attempts to control ravages of *Phytophthora infestans* with the Bordeaux mixture. Gives formulæ and method of treatment.

175. ———. **An experiment in preventing the injuries of potato rot.** Sci. Am., April 5, 1890, Vol. LXII, No. 14, N. Y., p. 217.

176. YEOMANS, W. H. **Bean rust and other fungous diseases.** Popular Gardening, Buffalo, N. Y., November, 1890, Vol. VI, No. 2, p. 27. Notes very destructive fungous diseases of bean leaves. Scientific name not given.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF VEGETABLE PATHOLOGY.

Vol. VI. No. 4.

THE JOURNAL OF MYCOLOGY:

DEVOTED ESPECIALLY TO THE STUDY OF FUNGI IN THEIR RELATION TO PLANT DISEASES.

EDITED BY

THE CHIEF OF DIVISION AND HIS ASSISTANTS.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1891.

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VOLUME VI, No. 4. } JOURNAL OF MYCOLOGY. { ISSUED April 30, 1891.

EDITED BY

THE CHIEF OF DIVISION AND HIS ASSISTANTS.

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EXPERIMENTS IN THE TREATMENT OF PLANT DISEASES.

By B. T. GALLOWAY and D. G. FAIRCHILD.

PART II.

TREATMENT OF PEAR LEAF-BLIGHT AND SCAB IN THE ORCHARD.

Dr. W. S. Maxwell's orchard, where these experiments were conducted, is situated near Still Pond, Maryland, in a region known as the Eastern Shore. This region is justly celebrated for its abundant yields of fruit, pears in particular being one of the most profitable crops. Of late years, however, this fruit has suffered greatly from the attacks of two diseases commonly known as leaf-blight and scab. These maladies are not confined to the Eastern Shore. On the contrary, we find them causing more or less damage wherever the pear is grown, so that these remarks are in a measure applicable to the whole country.

The leaf-blight and scab are caused by two very different species of fungi, which have received the rather formidable names of *Entomosporium maculatum*, Lév., and *Fusicladium pirinum*, (Lib.) Fckl., respectively.

The Entomosporium has already been made the subject of some investigations by this Division,* but no work in the line of preventing the injuries of the Fusicladium have, previous to this year, been undertaken. Dr. Maxwell being a heavy loser every season from both the diseases, and having placed his extensive orchards at our disposal, it was decided to carry on the work at his place.

* Circular No. 8, 1889; Bulletin No. 11, 1889.

PEAR LEAF-BLIGHT.*

In the work on this disease an effort was made to throw some light upon the following questions:

I. The relative value, as preventives of the disease, of the Bordeaux mixture, the ammoniacal solution, mixture No. 5,† copper carbonate in suspension, and copper acetate.

II. The number of treatments necessary to obtain the best results at the least expense.

III. The relative value of early and late sprayings.

IV. Cost of each treatment.

The orchard chosen for the work consisted of Bartlett standards, Bartlett dwarfs and Duchess dwarfs, all of which were last year early defoliated by the leaf blight.

Following is a detailed account of the work taken from our field notes:

1. BORDEAUX MIXTURE.—*One treatment to two adjacent rows of* 54 *Bartlett standards.*—The treatment was made May 29, after the foliage was already partially diseased, numerous patches of the fungus being plainly visible on many of the leaves. Forty-four gallons of the mixture were used, costing 92 cents, or 1.7 cents per tree. The labor of preparing and applying was 60 cents, or 1.1 cent per tree, considerably less than in the experiments on a smaller scale.

Results.—The difference between the sprayed and unsprayed rows was very great, the latter appearing almost entirely bare on September 24, while the former were still in full leaf. Had the appliances at hand permitted the topmost branches to be sprayed thoroughly the difference would have been still more striking. It may be well to add here that for the entire work we used a Nixon Little Giant machine provided with 16 feet of hose and a Vermorel nozzle. Two men were required to work this apparatus, one to do the pumping and move the machine from tree to tree, the other to handle the nozzle. The machine did its work quickly and efficiently as is shown by the very small cost of the treatment.

The apparatus as it was used cost somewhere in the neighborhood of $40. We are satisfied, however, that a machine fully as efficient could be constructed by any intelligent person for less than half the above sum. Such a machine, made by us the past season and used in treating nursery stock, consists of a small force pump fastened to a barrel, the latter in turn being seated upon a sled which is drawn by a horse or mule. The machine, provided with 14 feet of hose and a Vermorel nozzle, can be made for about $18. This apparatus requires a horse, a man, and a boy to work it, and while it is an easy matter to spray as

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* *Entomosporium maculatum*, Lév. For an account of the life history of this fungus see Annual Report of the Commissioner of Agriculture, 1888, p. 357.

† Composed of equal parts of ammoniated copper sulphate and sodium carbonate.

rapidly with it as with the Little Giant, experience has shown that in the end it is more expensive on account of the extra labor involved in working it. A machine to be drawn by hand can readily be made, the materials required being a two-wheeled truck, a barrel, a force pump, hose, and Vermorel spraying nozzle. Such an apparatus can be constructed for $14 or $15. The nozzle is provided with a three-fourth inch screw attachment, and instead of the old style degorger we now fit them with the same kind in use on our lance.*

Returning again to a discussion of the experiments:

II. BORDEAUX MIXTURE.—*Three early treatments to five trees of Bartlett dwarfs.*—The sprayings were made on May 5, 16, and 28, sixteen gallons of the mixture being used. It required 35 minutes to do the spraying, and, estimating the labor at $1.50 per day, the cost of it is 17 cents, or 3.4 cents per tree. The cost of the material was 34.7 cents, or 6.93 cents per tree, making the total expense of treating each tree three times, 10.33 cents.

Results.—On October 6 the treated trees were in nearly perfect foliage while the untreated in adjacent rows had dropped most of their leaves.

III. BORDEAUX MIXTURE.—*Three late treatments to five Duchess dwarfs.*—The dates of treatment in this case were May 28, June 23, and July 8. Sixteen and eight-tenths gallons of the mixture, costing 35 cents, were used. The expense for labor was 24 cents, making the total cost of the sprayings 11.8 cents per tree.

Results.—On October 6 the trees still retained a large part of their foliage while the untreated had lost every leaf.

IV. BORDEAUX MIXTURE.—*Six treatments to five Bartlett dwarfs.*—The treatments were made on May 5, 16, and 28, June 10, 23, and July 8. Thirty-six gallons of the mixture were used and 87 minutes were required to do the work, making the cost for the mixture 15.1 cents per tree and the labor 8.7 cents, a total of 23.8 cents per tree.

Results.—The foliage was completely preserved up to the time the frost removed it. It was, however, in no better condition than that in experiments II and III.

V. AMMONIACAL SOLUTION.—*One treatment to two rows of Bartlett standards containing* 54 *trees.*—The treatments in this and the following experiments were made on the same dates as I, II, III, and IV; moreover, all the other conditions were practically the same. Forty-four gallons of the solution, costing 33 cents, were used. The cost of labor in preparing and applying was 45 cents, making the total cost 78 cents, or 1.44 cent per tree.

Results.—The foliage on September 24 was not as well preserved as that of I, but it was much more perfect than that on the untreated trees. On October 8 the leaves had nearly all fallen.

VI. AMMONIACAL SOLUTION.—*Three early treatments to five Bartlett dwarfs.*—Treatments made on the same day as II, 22 gallons of the so-

* Illustrated in Vol. VI, No. 2, 1890.

lution costing 16.6 cents being used. The expense of application was 28 cents, making a total of 44.6 cents, or 8.92 cents per tree.

Results.—On October 8 the treated trees were in good foliage, while the adjacent untreated trees were leafless.

VII. AMMONIACAL SOLUTION.—*Five late treatments to twelve Duchess dwarfs.*—Treatments made May 28, June 10, and 23, July 8 and 19, 58 gallons of the liquid costing 43.5 cents being used. The cost of labor was 42.5 cents, making a total of 86 cents or practically 7 cents per tree.

Results.—On September 24, the foliage was only partially removed by the disease and the contrast, though not striking was quite apparent. On October 8 the contrast was much more marked.

VIII. AMMONIACAL SOLUTION.—*Six treatments to three trees of Bartlett dwarfs and four of Bartlett standards.*—Dates of treatments as in IV, 67 gallons being used at a cost of 50.2 cents. The cost of application was 58 cents, making a total of $1.08, or 15.4 cents per tree.

Results.—The standards showed the effects earliest and most markedly, but both held their foliage well into October while surrounding unsprayed trees dropped their leaves before the last of August.

IX. MIXTURE NO. 5.—*Six treatments to five trees of Bartlett dwarfs.*—Applications made the same as in IV, 36 gallons, costing 43 cents, being used. The cost of application was 45 cents, making the total expense 17.6 cents per tree.

Results.—The foliage was badly burned and many leaves dropped in consequence, but the leaf-blight was effectively prevented.

X. COPPER ACETATE.—*Three treatments to two Bartlett standards.*—The applications were made May 28, June 23, and July 8, using a solution of 3 ounces of the acetate to 6 gallons of water. Nine gallons of the mixture, costing 8.6 cents, were applied at an expense of 10 cents for spraying. The total cost therefore was 18.6 cents, or 9.3 cents per tree.

Results.—On October 6 the foliage was in a fair state of preservation, while adjacent untreated trees were leafless. No noticeable damage was done to the foliage, only an occasional leaf being injured.

XI. COPPER ACETATE.—*Six treatments to five trees of Bartlett dwarfs.*—Dates of treatment as in No. IV. Forty gallons of fluid were used, 4 gallons of a strong mixture (4 pounds to 22 gallons), and 36 of a modified (12 ounces in 24 gallons) solution, at a total cost of 62 cents, or 12.4 cents per tree. The cost of application amounted to 45 cents, or 9 cents per tree, making the total expense per tree 21.4 cents.

Results.—The leaves were severely injured, many of them falling long before the proper time. There is no doubt as to the fungicidal properties of this preparation; its use, however, can not at present be recommended.

XII. COPPER CARBONATE IN SUSPENSION.—*Six treatments to five trees of Bartlett dwarfs.*—The solution made by mixing 3 ounces of

copper carbonate in 22 gallons of water was applied on the same dates as IV. Forty-three gallons of the solution were used, but after the first two applications, which seemed to have little effect, the strength was doubled. The total cost of the treatments with this preparation was 13.3 cents per tree.

Results.—The disease was in a measure prevented, but the difference between the treated and untreated trees was not worthy consideration.

SUMMARY OF RESULTS.

Before summing up the results it is proper to state that the season was one exceedingly unfavorable for such an experiment, as the disease even on the untreated trees did comparatively little damage. We feel warranted, however, in drawing the following conclusions from the work.

I. The relative value of the preparations used in treating leaf-blight stand in the order named:

Bordeaux mixture.
Ammoniacal solution.
Copper acetate (3 ounces to 6 gallons).
Mixture No. 5.
Copper carbonate in suspension.

The difference between the Bordeaux mixture and the ammoniacal solution is scarcely perceptible, and if the cost is considered the latter stands first.

II. The best results at the least expense were obtained by the *early* treatments. It is well to add here that we do not accept this evidence as conclusive; on the contrary, we are inclined to think that had the disease been severe three treatments would not have been sufficient to hold it in check.

III. Early sprayings are unquestionably better than late ones.

IV. The cost of the various treatments will, in a measure, depend on the kind of spraying apparatus used, the distance from places where chemicals may be obtained at wholesale rates, and skill of the operator. It may safely be put down that for orchards of one thousand or more dwarfs the cost for treating with the Bordeaux mixture need not exceed 2 cents per tree for each application. For standards the cost will reach 3 cents or perhaps a little less.

In treating with the ammoniacal solution, which is the only additional preparation worth considering in this connection, the cost for dwarfs will average in the neighborhood of 1½ cents per tree and for standards 2½ cents.

From one season's work it is of course impossible to draw any definite conclusions as regards the direct benefit to the trees resulting from the treatment. It is reasonable to assume, however, that if the leaves on a tree, and especially a fruit tree, can be made to continue their normal work until frost, they will enable the tree to make a better growth, set more fruit buds, and consequently bear more fruit the

ensuing season than one which loses its foliage in midsummer. There is, however, a more important matter to consider in this connection, and that is the life of the tree itself. We know that in sections where the leaf-blight is severe a tree soon succumbs entirely to the disease. While we have no data bearing on the longevity of treated trees there is no room to doubt that they can at least be made to live their allotted time.

TREATMENT OF PEAR SCAB.*

These experiments were carried on in the same orchards and at the same time as those described in the preceding pages. Owing to the fact, however, that very little fruit set the work was far from satisfactory. At the time of the first treatment the fruit was about half an inch in diameter and stood erect upon the pedicels. The Bordeaux mixture, ammoniacal solution, mixture No. 5, copper carbonate in suspension, and acetate of copper were used, an effort being made in all cases to bring out, if possible, the relative value of the fungicides as preventives of the disease, the effect of early and late sprayings, the relative value of three and six treatments, and the cost of each application. Without going into the details of the work it may be said:

I. That in no case were the sprayings made early enough, as scab spots had already appeared on the fruit when the first applications were made. It was clearly evident that one spraying should have been made when the flowers were beginning to open and another when the fruit was about the size of peas.

II. There was no material difference so far as the amount of scab was concerned between the trees treated early and late and those which received three and six sprayings, respectively. By early here it must be borne in mind that we mean when the fruit was half an inch in diameter.

III. The costs of the treatments were found to be practically the same as those for pear leaf-blight. When one intends to spray for leaf-blight it will be an easy matter to begin earlier and treat the scab at the same time. In spraying for both of these diseases it would be well to make the first application as described above for scab, then follow with additional treatments at intervals of 12 or 15 days until six or seven in all have been made. In the present condition of our knowledge the Bordeaux mixture is the preparation most to be relied upon as effective against both leaf-blight and scab, and at the same time not injurious to the fruit. Should early treatments alone be made the case would be altered.

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* *Fusicladium pirinum,* (Lib.) Fckl.

THE PEACH ROSETTE.

PLATES VIII–XIII.

By ERWIN F. SMITH.

In the first bulletin on peach yellows some account was given of a peculiar peach disease prevalent in Georgia and not visibly associated with fungi. This account was based on correspondence and specimens received through the mails. In some particulars the specimens agreed exactly with yellows. In others they differed somewhat, and I was in doubt what it should be called. A full opportunity to examine it in the fields and orchards of middle Georgia in the summer of 1890 still left me with some doubt. It seems best, therefore, to call it "the peach rosette" until it can be determined whether it is identical with yellows, as now seems probable.

This disease agrees with peach yellows, as already defined, in the following important particulars:

I. On some of the trees winter buds and obscure buds push into diseased, branched growths identical with yellows. All of the growths would be identical if the shoot-axes were elongated.

II. Winter buds show the same tendency to unfold in summer and autumn. I saw such immature, feeble growths as late as November 6.

III. Part of a tree may be affected while the rest appears normal.

IV. The disease can be communicated to healthy trees by inserting diseased buds. In my inoculations of June 21, sixty per cent of 125 stocks showed symptoms of the disease in four and one-half months.

The disease differs in the following particulars:

I. The entire tree is more apt to be attacked all at once, and the disease is more quickly fatal. Trees often die the first year, and I have not heard of any cases living beyond the second season. What corresponds to the first stage of yellows *seems* to be wanting.

II. On the parts attacked, many obscure buds and all or most of the winter buds push into diseased growths suddenly *in early spring.* The primary shoot-axes grow only an inch or two, but send out many short branches. This gives to each growth a compact tufted form, and to the affected tree a very peculiar appearance unlike anything heretofore described, and much resembling the work of insects. These stunted, green, or yellowish rosettes often form the only foliage of large trees, projecting from the ends of long, naked twigs like leafy galls, or like house leeks tied to the ends of sticks (see Pl. IX).

III. The lower leaves on these tufts or rosettes roll and curl, turn yellow, dry up at the ends and edges, and fall early. They begin to drop before midsummer, and a slight jar shakes them off by the hundred.

IV. On the trunk and base of the main limbs it is rare to find anything more than rosettes, and often these also are wanting, the diseased growths being confined to the extremities of the branches.

V. Diseased trees seldom bear fruit of any sort. Most growers deny that such trees ever bear premature fruit, but one man who has lost two orchards insists that he has seen it. No fruit could be found in Georgia peach orchards in 1890, and this point was necessarily left unsettled

VI. The disease occurs in wild and cultivated plums, to which it is quickly fatal. Thousands of the wild Chickasaw plum (*Prunus Chicasa*) have been killed by it during the last few years. I also saw it in two Japanese varieties—Kelsey and Bhotan—and in one or two American varieties probably derived from *P. Chicasa.*

If this malady is yellows, our definition of that disease must be somewhat modified and enlarged to include the plum or at least certain varieties of it. My previous statements relative to the immunity of the plum were based on observations north of Virginia and had special reference to varieties of *Prunus domestica.*

This disease has been in upper middle Georgia for at least 10 years, and during this time has destroyed whole orchards. With some noteworthy exceptions it has not swept away budded orchards as quickly as the yellows of the North, but it takes some trees every year, and is evidently a dangerous enemy. This is true especially, because of its prevalence in the hardy wild plum which grows everywhere. During my visit I saw the disease in twelve counties: Fulton, Clayton, Campbell, Henry, Spalding, Pike, Meriwether, Coweta, Troup, Talbot, Harris, and Muscogee, and heard of it in ten others: Upson, Monroe, Bibbs, Butts, Jasper, Putnam, Greene, Taliaferro, Morgan, and Oglethorpe. It is widespread and well established in that part of Georgia.

The disease attacks cultivated and neglected orchards, young and old trees, seedlings and budded fruit. If anything, it is more prevalent in thickets and waste places, the edge of forests, and on the borders of streams, or by the wayside, than in orchards. It is not restricted to any special kind of soil or prevented by any method of cultivation. It occurs on the common red clays, on the gray and granitic sandy lands, and on a chocolate-colored, deep, fertile loam, commonly called "mulatto land."

A disease which appears to be identical (see Pls. XI–XIII) occurs also in Kansas. So far as known, it is now present only at Manhattan, and has not yet appeared in the important peach districts of southern and southeastern Kansas.

The attention of the writer was first directed to the disease by Mr. T. C. Wells, who sent specimens in 1889. The malady continued in 1890, when Dr. Kellerman also sent specimens and made inquiries. Later in the year I was able to examine it more carefully in the orchards themselves.

The farm of Mr. Wells is in the Kansas River valley, on a fertile, rolling prairie, about midway between the bottom lands and the limestone hills, *i. e.*, on what is called the "second bottom." The soil is a dark and a very deep loam, gradually shading into a reddish brown,

clay subsoil. In moist seasons this soil yields from 40 to 60 bushels of shelled corn. Apples, plums, grapes, elms, negundos, etc., also grow in it vigorously. The soil must contain plenty of lime, since horizontal, eroded ledges of limestone crop out everywhere on both sides of the Kansas valley for miles and miles.

This orchard of choice budded fruit contained only about two hundred trees, but they had always been thrifty and well cared for. The older trees were 8 to 12 years old and had borne several good crops; the younger (about fifty replants) were 4 to 6 years old and had borne only one crop.

Mr. Wells first noticed this disease in 1889. He says there were no cases in his orchard prior to 1889. That year more than 75 per cent of the trees became affected in whole or in part. The disease appeared in the spring and most of the trees were dead or dying when cut down the following autumn. A very pestilence seemed to have stricken the orchard.

In August, at the time of my visit, only about fifty trees remained. These were replants, 4 to 6 years old, and had been thrifty. Dr. Kellerman and Mr. Swingle carefully examined them in July, 1889, at which date about one-half were healthy. Dr. Kellerman accompanied the writer in an examination and we could then find only two healthy trees. The rest were diseased in the same way as the cases of the previous year—some were dead and the others showed symptoms throughout or on a part of the tree only. All trees which were noted as affected in July, 1889, were dead or dying.

Neighboring orchards were almost as badly affected. Most of these were neglected seedling trees in sod ground. About one hundred cases were also observed in a peach thicket where the struggle for existence was severe. In none of these places could I satisfy myself that the disease had been present more than two seasons, and the question of its origin is exceedingly obscure.

As in Georgia the terminal shoot-axes were developed into tufts all over the tree, but usually these were somewhat less compact. None of the peach trees had developed any luxuriant branched growths on the trunk or base of the main limbs as is common in the yellows of Maryland and Delaware, but the winter buds were pushing in the same way. Last year some of these trees bore fruit, but I could not learn that any of it ripened prematurely. Frequently one-third to two-thirds only of the tree was visibly affected. Occasionally trees would be diseased, dwarfed, and yellow throughout, except one or two small terminal shoots in the top of the tree. These, in striking contrast, bore leaves of normal size and color. This also happens in Maryland and Delaware in ordinary yellows.

This disease was also observed in cultivated plums of the Chickasaw type and in the hard shell almond. I have no hesitation in saying that it is identical with the disease which occurs in Georgia.

This rosette disease resembles yellows very closely, to say the least, and there are transition forms in both States, and growths not distinguishable from genuine yellows. The absence of the prematurely ripened fruit may be due to the suddenness and severity of the attack. The long, dry summer or other climatic peculiarities of these two regions may possibly account for this, and also for certain other symptoms at variance with the yellows as heretofore known and described. These are points to be worked out hereafter.

The disease in Georgia has been erroneously attributed to the attacks of Scolytid beetles. * *Scolytus rugulosus* is common in Georgia, and rather destructive, but in June the mother beetles were only just commencing to burrow into the bark preparatory to depositing their eggs, *while the trees had been affected with this disease for several months.* Moreover, in June there were many diseased trees which had not yet been attacked by a single beetle or had only a few borings. To satisfy myself I examined some of these carefully over every square inch of their surface; cut the bark open in every direction, and examined each one of several thousand rosettes, *e. g.*, the tree figured on Plate IX. In July it was more difficult to find such trees, although not impossible, *e. g.*, on June 30, in company with Mr. Rudolph Œtter, I examined four trees in a middle-aged, seedling orchard near Griffin, Ga., with the following results:

(1) This tree was nearly dead and the rosettes had a droopy look. In a section of one limb, which was not over 1½ inches in diameter and 2 feet long, we found 83 excavations made by *Scolytus rugulosus.* The beetles were present and burrowing in most of these holes, but not yet buried out of sight. The evidence of recent occupation was strong.

The tree probably contained a thousand beetles, but most of them had been at work only a few days. They had bored into the base of many of the rosettes, and this was what gave to the foliage its wilted, drooping appearance. This tree died in July, 1890. It was probably attacked by the rosette disease in 1889.

(2) This tree was diseased in all parts, and did not bear a single full grown leaf or shoot-axis, but the rosettes were still green and fresh. This tree was even more minutely examined than the preceding. In the trunk and main branches there were no beetles, no holes, and no internal borings or chambers. There were also very few injuries on the smaller twigs, the most careful search bringing to light only half a dozen.

(3) This tree contained many beetles. The foliage was wilted and drying up as in No. 1.

(4) This tree was like No. 2 in appearance. It was also like it in being almost completely free from beetles or borings due to them.

No larvæ or pupæ were found in any of the trees.

It is wholly impossible to account for several thousand diseased growths scattered over the whole top of a tree by the slight borings of a few dozen beetles, even admitting their constant presence in the

* *Proc. Georgia State Hort. Society,* 1889, pp. 16 and 46.

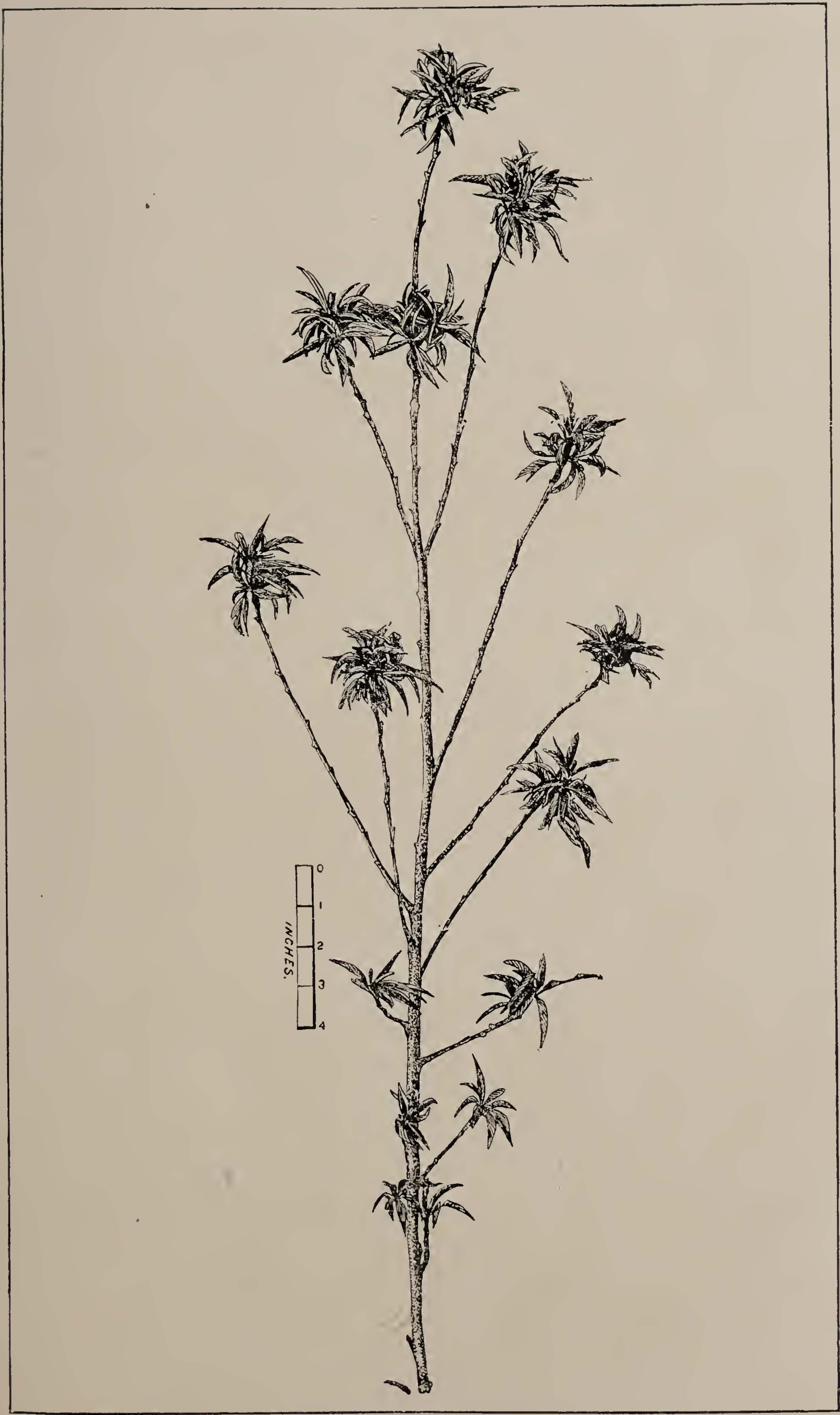
HEALTHY PEACH TREE.—GEORGIA.

T[illegible] R[illegible]TE.—GEORGIA.

THE ROSETTE.—GEORGIA.

THE ROSETTE.—KANSAS.

THE ROSETTE.—KANSAS.



THE ROSETTE.—KANSAS.

early stages of the disease, which is by no means the case. As a rule, beetles of this group prefer sickly trees. Late in the season many such trees were riddled by *Scolytus*, but they did not appear in numbers until June. The time to make such an examination is in the spring when the disease first appears and not in summer or autumn when the trees are nearly dead. In spring, when the cause of this rosette disease is very active, the *Scolytus rugulosus* can do no harm, because it is then undergoing transformations in the trees which were attacked the previous year. Larvæ and pupæ were taken from a number of such trees. They were generally in winding passages in the wood, and were most abundant in some plum trees not suffering from this disease.

Moreover, repeated observations in Kansas during a two-weeks' visit failed to discover a trace of this insect. Neither had the Experiment Station entomologists ever seen it. The probabilities, therefore, are that this species has not yet appeared at Manhattan.

The *Scolytus rugulosus* does not cause this disease, nor do I think it due to any other insect. Whatever be its cause, the disease is evidently increasing, and peach-growers should be on the alert to destroy it as soon as it appears. The affected trees should be dug out and burned as soon as discovered. The contagious nature of the disease is now beyond dispute, and it is not wise to let them remain a single day.

EXPLANATION OF PLATES.

PLATE VIII. Healthy peach tree from an orchard of budded fruit near Griffin, Georgia. Set 2½ years. This tree stood upon cultivated, level, fertile "mulatto land." Photo, June 28, 1890.

PLATE IX. Tree attacked by the rosette—a typical case. This tree stood in the same orchard as VIII and not over 20 feet distant. It was healthy in 1889. Photo, June 28, 1890, at which time it did not bear a single leaf or shoot-axis of normal character. The bark on the trunk of this tree had been injured by a borer (*Ægeria exitiosa*, Say) but over an area not larger than a silver dollar. There were no other injuries by borers; no bruises, and no borings by *Scolytus* anywhere on the trunk or main limbs. To determine the amount of twig injury attributable to *Scolytus*, I examined each one of the several thousand tufted and growing shoot-axes, and all of the internodes, finding three beetles and fifty slight injuries. All these were of recent date, and many did not reach into the cambium. There were no larvæ and no winding passages under the bark. Usually the gnawings were at the base of the tuft on the upper side in the acute angle formed by the shoot and the older stem. These injuries were generally vertical and seldom over one-eighth of an inch long or broad. In no case was a twig of the previous year's growth girdled or so injured as to affect shoots above the boring. The worst injuries amounted simply to the killing of the particular shoot-axis bored into. These had dried up and were easily distinguishable from the uninjured majority. The fact that the dead shoots were nearly as large as the rest showed clearly that the injuries were of recent date, whereas the tree had been diseased throughout for several months, *i. e.*, ever since it began to grow in the spring. The fifty injuries by the beetles were not more serious than would have been a like number of stabs with an awl. Later in the season no doubt the tree might have been full of beetles and larvæ.

PLATE X. Rosettes from a seedling tree near Sunny Side, Georgia. This tree showed symptoms of disease on only about one-half of its branches. On some of the branches the winter buds had germinated, especially toward the upper ends of the shoots. Photo, July 2, 1890.

PLATE XI. Diseased peach tree from the budded orchard of T. C. Wells, Manhattan, Kansas. Much smaller than the average. Healthy in 1889, but now affected in all parts. There were no injuries by borers, root aphides, root knot, or *Scolytus*. The winter buds were germinating on some of the tufts. Photo, August 16, 1890.

PLATE XII. Diseased branch from a seedling tree in the orchard of W. J. Griffing, Manhattan, Kansas. Whole tree affected in the same way. An extreme case of tufting. Photo, August 23, 1890.

PLATE XIII. Diseased branch from a seedling tree in the orchard of W. J. Griffing, Manhattan, Kansas. The whole tree was affected. Photo, August 18, 1890.

TUBERCULOSIS OF THE OLIVE.

PLATES XIV, XV.

By NEWTON B. PIERCE.

During the summer of 1890, I enjoyed the opportunity of meeting, under the most pleasant circumstances, Dr. Luigi Savastano, professor of arboriculture of the Royal High School of Agriculture, at Portici; the latter a beautiful town situated at the base of Vesuvius, on the shores of the Bay of Naples. Dr. Savastano has recently done some excellent work on the tubercle disease of the olive, having conducted several series of experiments with cultures and inoculations which have resulted in clearly demonstrating the bacterial nature of this most interesting malady. These experiments have been carefully repeated by Dr. Fridiano Cavara, of the well-known agricultural school of Pavia, south of Milan. The result has been equally conclusive and interesting. It was my good fortune and pleasure to meet both Drs. Briosi and Cavara of this school, and to have the opportunity of seeing much of their valuable work. The writer was shown an olive tree into which bacilli of the olive tuberculosis had been introduced, and which was showing at the points of infection well-developed tubercles. At its side stood another olive of like size and similarly conditioned, which had been treated in all ways as its companion with the exception that the wounds made by the knife had never received the germs. No signs of a tubercle were to be seen upon this tree. The organisms used in these experiments were from artificial cultures.

During the author's labors in the Mediterranean region, tuberculosis of the olive was encountered at several places and under various conditions. On this account the liberty is taken to append a note or two to a translation of the published account of the concluding experiments of Dr. Savastano.* There is also given a reproduction of figures pub-

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* *Il Bacillo della Tubercolosi dell' Olivo, Nota Suppletiva del dott.* L. Savastano. Roma, 1889.

lished by Drs. Cavara and Briosi, showing the section of a tumor with the location of the bacilli in the tissues, as well as the germs themselves as seen in the stained preparations on the slide. I was shown while at Pavia the preparations from which the sketches were drawn, and will say they are fairly represented in the figures given. To supplement this there have been added figures from my own material and photographs of affected olive branches, showing the location and various stages of the tumors *in situ.*

Dr. Savastano's account of the disease is as follows:

In my study of the tuberculosis of the olive (commonly *scab of the olive*)* I established the presence of a pathogenic microörganism in the tumors, cultivated it, inoculated with it, and obtained by means of it the formation of tumors. I explained that owing to circumstances over which I had no control I was unable to complete the study of this microörganism with the thoroughness which bacteriology requires. Having obtained the means for undertaking the researches in the bacteriological laboratory of the Zoölogical Station at Naples,† I have resumed the study which I was reluctantly obliged to leave incomplete.

The characteristics of the pathogenic microörganism of the tuberculosis of the olive are the following: The cultures are made in a way to avoid error only when incipient tumors are used. If they are made from old tumors it is necessary to take the inner part of the cambium zone. Taking the external part, only the microörganisms of the air are found.

This microörganism is a Bacillus of medium size; length three to four times its width; it is isolated, but is sometimes joined into chains; the extremities are slightly rounded off. In drops of bouillon it has a distinct movement. The colony has a variable form, from round to oval, with a well-defined margin. In the beginning it is uniformly pointed; later it forms one or two peripheral circles. It is whitish by reflected light, cedar-color by transmitted light. The bacillus lives well in ordinary culture media (bouillon, potato, gelatine, agar). I have attempted to make another medium for culture with material taken from the olive. It did not prove very suitable, and the preceding media are preferred. Gelatine does not liquefy in our climate from January to April; from May to June it liquefies slowly. The culture has a relatively long life; cultures made in March were still living in June. In short, degeneration begins in about 3 months. The bacillus stains very well with simple aniline colors. I have not been able to establish a distinct spore formation. The method of double staining does not succeed very well, because the cell wall takes up the aniline colors more easily and gives them up with greater difficulty than the microörganisms.

On the potato it lives very well and develops rapidly; the colonies are at first like so many small round dots, translucent straw-color, which, as they develop, form on the surface of the potato a uniform stratum, translucent, and of a deeper color. The bacillus acquires greater dimensions.

On the gelatine plates it lives very well, with characters and forms as above indicated. In tubes of gelatine *a becco* the culture presents the appearance of a uniform stratum, whitish, the margin finely bilobed, reminding one of the margin of a leaf, the whole culture taking the form of a spatulate leaf. It is slightly dichroic.

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* *Tubercolosi, iperplasie e tumori dell' olivo. I. II. Memoria.* Annuario R. Scuola Sup. d'Agricoltura in Portici, Vol. v, fasc. 4, 1887.

†The equipment for bacteriological work in the Naples Station has been but recently added, we believe. The station now has the facilities for doing good work of this class. Mr. H. Linden, in charge of the station, who has our thanks for courtesies extended during our stay at Naples, fully convinced us, after a careful inspection of the laboratories and general accommodations of the institution, of the desirability of more American students reaping the benefit of the advantages there offered.—N. B. P.

In tubes of agar *a becco* the culture is indentical with the preceding, the margin is less bilobed.

The culture by needle in gelatine presents a uniform, transparent, finely pointed appearance. On the surface of the meniscus the form is irregularly rounded with a finely lobed margin as in the preceding.

In the different materials taken from the olives of Puglia, Calabria, the Vesuvian region, and the Sorrentine peninsula, I have demonstrated in each case the same microörganism in the cultures.

In tumors which had been gathered about a year the Bacillus had been destroyed.

In the cortical tubercles and in their miliary form I have demonstrated the same Bacillus. I have performed three series of inoculation experiments. I have practiced the same method of inoculation which I had before adopted.

Series I. Inoculation of pure cultures in olive plants.—The plants used were all grown from seed, some were raised by myself, others were given me by Signor R. Pecori, of Florence, from his establishment. The plants were taken from seed and not from cuttings, to avoid heredity from the mother plant which might be infected.

The inoculations were made April 27 of the current year. By the 1st of June the tumors were already evident, and by the 1st of July were much developed. The controls have not given signs of tumors. These results are the confirmation of those obtained roughly by me and with impure cultures in 1887. I am able to conclude that *the disease of the tuberculosis of the olive* (commonly scab) *may be produced by a specific pathogenic Bacillus which I name Bacillus oleæ-tuberculosis,* understanding the tubercle in the sense of botanical pathology.

Series II. Inoculations of the Bacillus in other plants.—The conditions of inoculation are identical with the preceding and on the same day in the following plants: peach, plum, apricot, grape, fig, pear, apple, bitter orange, lemon, rose, *Abies excelsa, A. pectinata, Cedrus Libani.* Till now (July 30) I do not see the least sign of a tubercle; the wounds are perfectly closed and healed. I am able to conclude from this that *these bacilli are not able to produce the same pathological effects in the plants indicated.*

Series III. Inoculations of other microörganisms in olive plants.—With the identical conditions preceding I inoculated into olive plants the following microörganisms which I am studying in the said Zoölogical Station: (1) A bacillus obtained in small tubercular swellings of the plum; (2) a second bacillus obtained as the preceding; (3) a bacillus found in the gums of citrous plants; (4) one of the bacilli of the pus of the citrous plants; (5) a bacillus of the cancer of the vine. Not one of the many inoculations has produced a tumor. Could this be done the tuberculosis might be produced by any microörganism whatever. *This third series of experiments indicates much more certainly the pathogenic power of the Bacillus of the tuberculosis of the olive.*

General observations.—The tubercle of the olive is an excrescence upon the limb of the tree which might pardonably be at first mistaken for an insect gall. These excrescences or tumors are quite variable in size, probably most of them are mature before reaching an inch in diameter, but some become large coarse knots. Many branches cease to grow, in whole or in part, beyond the tubercle, after the latter has become partially developed. Some branches become stunted while others die entirely toward the end. Hence the growth of the tubercle is largely limited by the vigor and life of the limb bearing it.

Dr. Savastano says* that the tubercles occur upon branches from 1 to 15 years of age. In forming, the tubercle commonly takes its origin quite near the cambium zone, though more frequently the center of bacteria begins to form in the liber portions of the fibro vascular bundles. To the unaided eye the forming center appears like a very small

* *Comptes Rendus.* Paris. T. CIII, p. 1144.

transparent spot, which, under magnification of 1,000 diameters shows the colony of bacteria already formed. There is now manifest about the colony a hypertrophy of the elements which may become more or less profoundly altered. As the colony enlarges the hypertrophy increases. The tubercle grows until in time it cracks through the exterior bark. When the tubercle is formed its growth is not usually arrested, but it continues to increase more or less in size each year, often attaining a diameter of 0.01 to 0.02 meter (two to four fifths of an inch). The tubercle is formed in the spring; during the heat of the summer the hypertrophy is arrested, but the colony of bacteria increases considerably. Then, during the autumn renewal of growth the hypertrophy begins again.

The irritation or stimulation caused by the presence of the bacillus, so far as our observations have extended, produces only a localized growth of tissue. There is scarcely more evidence of a general or constitutional disorder of the sap of the tree affected than is produced in the oak under the action of the Cynipidæ. The stimulation of the affected branch scarcely extends beyond the node or internode where the swelling occurs. The impoverishing action of this growth, however, is often plainly observed on the entire twig beyond the tubercle. The limb sometimes shows a marked reduction in diameter, though perhaps green and healthy in other respects. In a majority of cases the enlargement only involves one side of the branch. It is not uncommon to find two centers of inoculation producing coalescing tubercles; but the distinction of origin is rarely lost. So far as I am aware progressive death of the limb below the point of infection, as is the case with pear-blight, never occurs. There is no analogous and general pathogenic degeneration of the tissues as found in limbs affected by that disease.

From some of my first observations, where I found the tubercle developing at the node of the limb, I thought it likely that inoculation had been effected by means of the axillary buds. Later, however, many tubercles were noticed, located upon internodes, and having no connection with the leaf axil. This has left the method of entrance of the Bacillus obscured, unless, perchance, it be through the growing point, and continued growth has left it within the internode or at the node. This explanation seems more probable than that the organism has directly penetrated the bark of the branch. It is also rather indorsed than otherwise by the fact that whenever mechanical injury has occurred to the bark, laying bare the cambium tissue, the tumors are often unusually numerous. They are most common where a bud or leaf or branch has been broken off, or where some injury or splitting of the branch has occurred. In one case observed, where a branch had been split for a few inches, three distinct centers of inoculation were seen at the edge of the ruptured bark within the distance of 2 inches. Undoubtedly, however, inoculation may occur through slight cracking or other injury of the bark.

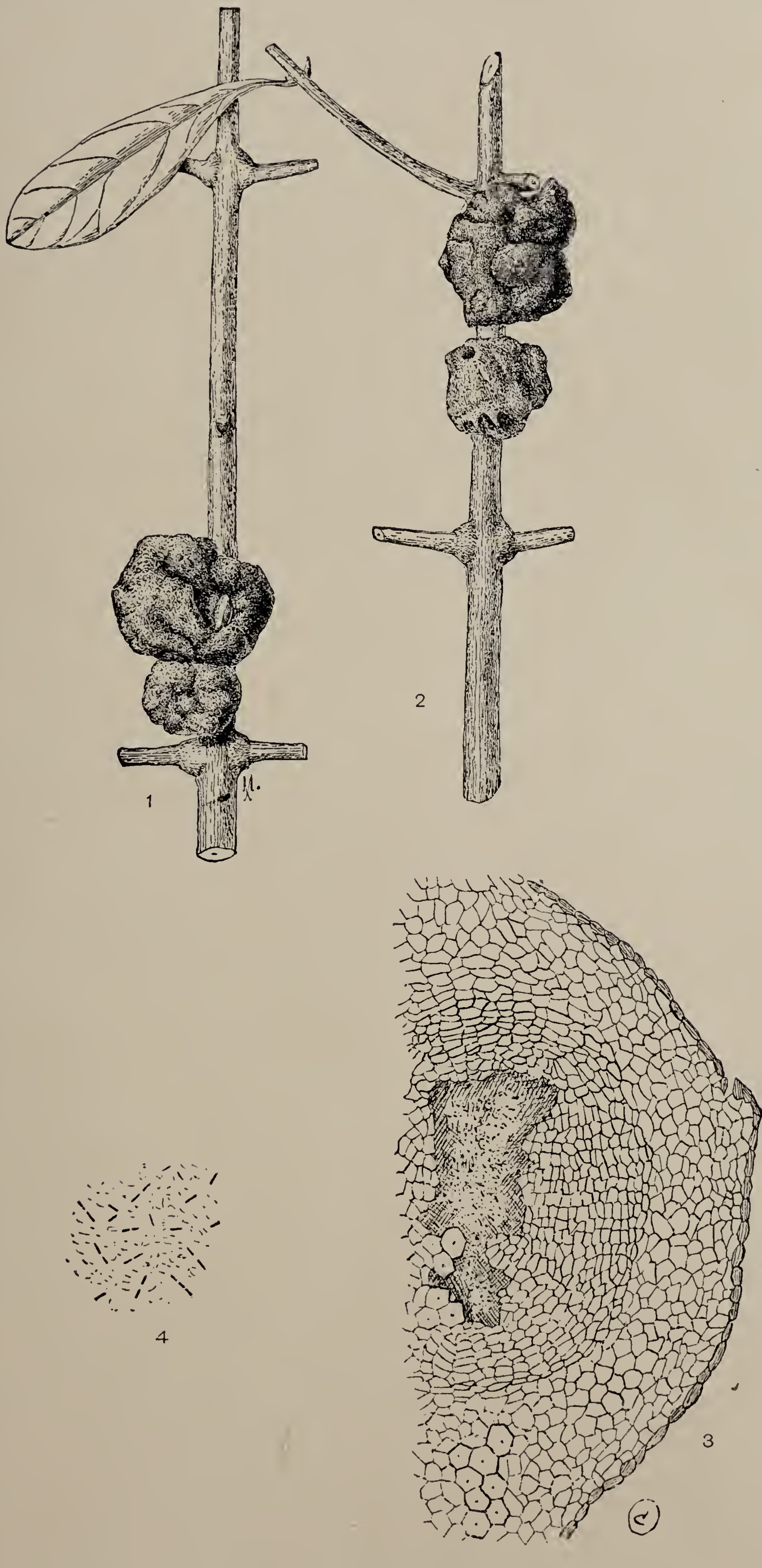
The local and general distribution of tuberculosis of the olive is peculiar and interesting. There is no such sweeping and complete infection accomplished by this disease as is the case in the spread of many germ diseases. I was told that near Genoa the disease is very common and quite destructive. At Rome I visited an olive grove near Colonna, some 16 miles from the city and north of the Alban Hills. In company with Professor Cuboni I made careful search for this disease, and only obtained a single tumor from a considerable number of trees examined. Another case somewhat similar occurred at Portici. The agricultural school building there was formerly a royal residence, and retains back of it an extensive park which was fitted up in connection with the residence or palace. Here is an extensive olive grove. Dr. Savastano, his assistant, and myself searched through this grove for some time for tubercles, only finding, at last, a few on the upper limbs of a single tree. At Cancello, some 12 to 15 miles north of Vesuvius, is a large olive grove covering the hills at that place. I here spent several hours in a fruitless search for this disease; at Palma, about an equal distance southeast of Cancello, the trees were quite badly infected. Upon a single small branch (the one shown on Plate XIV) I counted not less than twenty-nine swellings. All about the hills north of Messina, Sicily, especially in the neighborhood of Faro, the olives are badly infected, and in one or two cases nearly the entire top of the infected tree was ruined. In the province of Syracuse, where olives are largely grown, and where they are very old and thrifty,* no signs of this disease were seen. At Palermo, northwest Sicily, it was again encountered, and noted as being the worst phase of the disease seen up to that time. In Algeria I did not encounter the trouble, but have little doubt of its existence there, as well as in all of the Mediterranean olive-growing countries. It exists in France. My observations show me that the disease is very irregular in its distribution. One olive grove may be free from it, or nearly so, while another not far distant may be badly infected. One tree in a grove may be, apparently, the only one infected. Again, the disease may be localized upon one portion of a single tree. Probably nothing short of a clear understanding of the means of distribution and infection will explain these facts.

Careful attention to the excision of all affected branches is apparently all that is required to keep this affection from spreading and doing serious damage.

As the olive industry is becoming one of importance on the Pacific coast, it is well that those interested should have the facts relative to the various enemies of that industry placed before them. In this way they may become familiar with those diseases not yet affecting their groves, and may take steps which shall prove an ounce of prevention worth more than a pound of cure.

* Near Floridia, some 14 miles west of Syracuse, I found one magnificent old olive tree in perfect health, which measured 13 feet in diameter at the ground and 10 feet in diameter at 3 feet above the ground.

Pierce on Olive Tuberculosis.



PIERCE ON OLIVE TUBERCULOSIS.

EXPLANATION OF PLATES.

OLIVE TUBERCULOSIS.

PLATE XIV. Olive branch 18 inches long, bearing 29 tubercles, only part of which are seen in the plate, and none are fully matured. Several of the tubercles have but recently broken through the bark of the branch. This branch was cut July 29, 1890, from a badly infected olive tree growing in an old grove two miles south of Palma, in the province of Naples, Italy. Photograph of fresh material.

PLATE XV. FIG. 1. Well-matured olive tubercles of natural size, showing the usual ruptured condition of the top. The rupturing is preceded by a slight pitting at the surface, as shown in the lower tumor. Material from near Genoa, Italy.

2. Olive tumors from the same source as those of Fig. 1. The lower tumor shows an opening through which some insect has escaped, which inhabits the old tumor, and which may assist in spreading the disease.

3. Section through a tumor. Shows the hypertrophy of the tissue and the degeneration at the central part of the tumor where the bacilli are situated. After Briosi and Cavara.

4. *Bacillus oleæ* (Arcangeli), Trevisan. From figures of stained slide preparations by Briosi and Cavara. I have seen the original preparations given in Figs. 3 and 4.

RECENT INVESTIGATIONS OF SMUT FUNGI AND SMUT DISEASES.

AN ADDRESS DELIVERED BEFORE THE SOCIETY OF AGRICULTURISTS OF BERLIN, FEBRUARY 17, 1888.

By DR. OSKAR BREFELD.

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Translated from *Nachrichten aus dem Klub der Landwirthe zu Berlin*, Nos. 220–222, by Erwin F. Smith.

(*Continued from p.* 71.)

For the solution of the first question some important data have been pointed out already in speaking of the mode of infection, to wit, the application of the germs and their penetration into the host. From the results of the first five series of experiments it is evident that the period of receptivity in the seedlings is very transitory. The slower this stage of growth the more probable it is that the germ which has penetrated at the right spot will actually reach the growing point in the given time; and this must be reached if the nascent blossoms and fruits (the subsequent location of the smut beds) are to become smutty. On the contrary, the more rapid this stage of growth the less must be the probability that the germ can reach the growing point in the short time before the seedling begins to elongate. And from this point of view the most extreme case would be when a very greatly hastened development of all seedlings altogether prevented the passage of the penetrated germ into the growing point; in this case, in spite of all penetrated germs, the appearance of the smut diseases would be impossible.

Now, in the first place, the rate of development of seedlings may be very different for different kinds of plants, and in general it may well depend on this whether they are or are not susceptible to smut diseases;* furthermore, in the particular forms which are attacked, it may fluctuate noticeably according as they belong to special races or sorts, and consequently these are more or less receptive. But more than all this, in particular individuals of the same species of cultivated plant a somewhat hastened or retarded development during germination will assert itself in smaller fluctuations, which here nevertheless may be decisive. For this reason it seems only natural that the receptivity toward smut fungi will be individually different, that consequently in the same material, under otherwise similar conditions, only a portion of the host plants will become smutty, as was actually the case in our experiments. The fungous germs certainly penetrated into every seedling, but the growing point was not reached in all cases, and only those finally became smutty in which it was reached. To what extent the temperature may influence the result I will only point out briefly. Warmth hastens development, but whether it acts equally on the growth of the seedlings and on the fungous germs in them had to be decided by infection experiments conducted at higher temperatures than those here described. These supplementary experiments showed that when seedlings, as in I, were infected at 15 degrees C. only 3 per cent of the plants became smutty, while at still higher temperatures only 1 to 2 per cent appeared or no smutty plants whatever. † The higher temperature, therefore, hastens the growth of the seedling proportionately more than that of the fungous germ, and thus hinders the development of smut in the plants.

It now remains to ascertain the reasons why, in all the series of experiments, not a single one of the infected barley seedlings produced a smutty plant. In the first place, it is self-evident that the negative results with the barley can not change in the least the positive results with the oats. On the other hand, without further inquiry, the explanations given for the incomplete sickening of the oat plants are by no means to be urged

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* From the sum of the experiments and the preceding observations it follows naturally *that the simple penetration of the germ into the host plants,* on which the school of De Bary laid such stress, is not decisive for the appearance of smut diseases. But beyond this, I have by special experiments determined *that the most diverse smut germs can penetrate into all sorts of plants, which are never attacked by smuts,* consequently, the penetration of the germs only proves an unimportant detail. The results of these many experiments establish the accuracy of the views and conjectures on parasitism and the way it may occur in nature, of which I have already spoken in *Den Brandpilzen* I, p. 26–29.

† In the paniculate heads of the oat, sound spikelets sometimes occur at the tip of a panicle while the lower spikelets are destroyed by smut. In such cases the penetrated smut germs had not reached the uppermost point of the inflorescence when the elongation began; therefore these remained sound while the lower were attacked by smut. The correctness of this interpretation of the interesting discovery is shown by the fact that in such partially diseased panicles the *uppermost portions without exception are sound and the lower are diseased,* but never do the upper become diseased while the lower remain sound.

for the entire immunity from smut observed in the infection experiments with barley, and especially because barley in the field is more frequently attacked by the dusty smut than oats. The results remained a complete enigma for three long years. But then this case also was explained as naturally as imaginable.

I received accidentally from Yokohama, through Chief Brigade Physician, Dr. Kügler, some smutty spikes of barley. It occurred to me that it was worth while to see whether the dusty smut on the barley in Japan agreed exactly with the dusty smut in Germany. I therefore sowed its spores, which in shape and size were indistinguishable from our own dusty smut, in nutrient solutions. Here it came to pass that in the universal germination of the smut spores into a promycelium *no conidia* were produced upon the latter, although they appear in countless numbers, as we know, in the spore germination of our own dusty smut. The promycelium afterwards branched in the same way, and just as abundantly, as any mold, but in a purely vegetative manner, without any formation of conidia.

In this manner mycelial masses were produced of such dimensions as can scarcely be derived from Saprophytes upon slides. As soon as the nutrient solutions were exhausted the remotest threads grew out stolonlike, and spread to a great distance, just as I have described and figured it for several fungi in my cited book. *The smut on the barley in Yokohama is therefore a fungus distinct from our dusty smut.* Unfortunately it was spring, and I had for comparison no smutty barley grown in our own fields. But in the following summer, as soon as the smut showed itself in the barley fields, I made cultures from its spores and found that they germinated just like those from Japan. I repeated the experiment with barley smut taken from as many places as possible in the vicinity of Münster in Wesen, but the spores always germinated without conidia. I communicated this observation to my distinguished friend and patron, Prof. Julius Kühn, of Halle, and requested from him some spikes of wheat containing fresh smut. In these also was the same fungus as in the barley, the spores produced no conidia. *According to this the smut fungus on barley and wheat is not the same as that on oats.* In spite of the similar spore form a great difference between the two is shown in the germination of the spores in nutrient solutions.

The negative results of barley infections, and the endeavor to give a natural explanation, led to a further positive result, the discovery of a new form of smut, which, in spite of its universal distribution, had remained unknown, and for the recognition of which it was first necessary to find out, by means of the artificial culture of smut fungi, a new method of diagnosis. I call the new fungus, which occurs on the Hordeæ, *Ustilago hordei.* The consonant behavior of the fungus from Japan and from Germany is evidence at once of its specific peculiarity and its value as a member of the genus *Ustilago.**

*A varying behavior during spore germination in water, sometimes with and again without conidia, was known long ago for the dusty smut, but owing to the rudimentary germination of the spores in water was not followed further. Moreover, seven years

B: For the infection experiments with millet smut, *Ustilago cruenta*, I selected the largest kind of millet, viz, *Sorghum saccharatum* (*nigrum*), because in the others the seedlings are entirely too small and therefore not suited for the experiments. Even the seedlings of the sugar millet are quite small in comparison with those of our own cereals. They have, on the other hand, the advantage that at first they grow much more slowly than the seedlings of oats and barley.

The millet smut (*Hirsebrand*), like the dusty smut, appears in the fruiting spikelets, and the grains are changed into a black mass of smut.* The spores germinate readily and produce sprout conidia in endless abundance. These are deposited in the nutrient solution as a precipitate, which differs strikingly from that of the dusty smut in its whiter color and the non-gelatinizing membrane of the conidia.

I. The first series of experiments, in 1885, was reduced to 32 plants by a hail storm. The germinating embryos were infected with the sprout conidia of *U. cruenta* by means of the atomizer. Among the 32 plants which remained there were, in autumn, 12 smutty and 20 sound.

II. The next series of experiments was made in the following year by direct infection of seedlings, which, however, were not all of the same size or in quite the same stage of germination. In autumn the harvest of 270 plants yielded 120 sound and 150 smutty.

Early experiments, with sufficient materials, where the seedlings were rigorously sorted according to their size, were not begun till 1887.

III. First, the smallest plants, in which the growing point was just emerging from the grain, were picked out and infected. Here, in autumn, out of 250 plants were harvested 180 smutty and 70 sound.†

IV. Next, seedlings were selected with shoots a centimetre long. Here, in autumn, from 150 infected plants were gathered only 24 smutty and 126 sound.

V. Seedlings with shoots 1½ centimetres long. Here, in autumn, from 190 infected plants, 12 diseased panicles were counted; 178 remained sound.

VI. Seedlings with shoots 2 centimetres long and projecting from the sheath. In autumn, out of 220 plants only 4 were diseased, the rest were sound.

VII. Seedlings with shoots which had grown through the sheath to a distance of 1 centimetre. Here, in autumn, *no smutty plants* appeared.

VIII. As soon as the millet seedlings were large enough to be infected by spraying the germs into the heart from above, 192 plants,

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ago, in my first culture experiments with the dusty smut, I discovered that the smut spores from barley would not germinate even after one year, while those from oats still germinated readily after more than six years.

* In more than three hundred smutted millet plants, for which I have to thank Prof. Julius Kühn, I found the smut nowhere except in the ovaries.

† There can be no doubt that the larger per cent of smutty plants in the millet as compared with oats, is referable to the slower growth of the millet seedlings. Otherwise, on account of their smallness, the seedlings are less favorable objects for infection than those of oats.

which had reached a size of about 5 to 6 inches, were thus infected. Where the germs touched, a local sickening was visible after 4 to 6 days. This took the form of a yellowing and subsequent shriveling of the leaves. These were covered with penetration spots, and penetrated in all parts by richly branched fungous threads. The leaves died, but neither completely nor with the formation of smut in their interior. As soon as the plants were compensated by new sound leaves from the bud, they appeared healthy again; but were, of course, somewhat delayed in their development in proportion to the disturbance. Moreover, this whole series of plants proved sound, and brought forth healthy panicles.

IX. An additional 210 millet plants, about a a foot high, were infected in the heart from above. Here the effect was still more remarkable. The young leaves which had been touched and attacked, shriveled considerably after a week, the heart of the plant became very pale, and the mycelium grew luxuriantly through all the attacked leaves. Nevertheless, even here, the diseased leaves were subsequently replaced by sound ones, and aside from the delay in development the plants suffered no injury. The subsequent harvest yielded only sound panicles.

X. Again, 120 plants, 1½ to 2 feet high, were infected in the same way. The symptoms on the attacked leaves grew worse in proportion to the increased size of the vegetative point, so that from external appearances it seemed as if the plants would perish; but this did not happen, and again the new leaves were sound. The result in autumn was the same as before, only sound plants.

The panicle can not be reached by infection from above in millet any more than in oats. It is securely inclosed by the leaves of the bud, and subsequently pushes out sidewise from these. For this reason, additional infections, when the plants were 3 to 4 feet high, had a purely negative result. The young leaves were luxuriantly traversed by the penetrated germs, but the panicles remained uninjured.

The final result of the experiments with millet smut on the sugar millet [sorghum] points to the following conclusions: The plants can be infected with the smut germs in all young undeveloped parts; but only those smut germs which have penetrated into the *nascent* shoot, and have thus reached the growing point, actually produce smut in the panicles, which is its exclusive location. These fungous germs, which have penetrated the host plant in the first stage of germination, remain, as in oats, latent in the plants till their sexual maturity, and then only do they come to maturity in the young ovaries, and to the production of smut beds, which is equivalent to the destruction of the ovaries or of the panicle.

It is worthy of remark that we can not discover the least sign of disease in the plants which bear the destructive germ concealed in their growing points; that, on the contrary, they appear even more luxuriant than the others; and furthermore, that the smutty panicles appear much sooner than the sound ones. For example, in the third series of experiments. 102 smutty panicles had developed up to September 3,

but yet no sound ones. I fully believed that all of the plants would be smutty, until on September 10, the first sound panicle appeared. On October 1 were counted 30 sound panicles and 140 smutty ones; and finally, on October 15, the proportion was 180 diseased, smutty plants to 70 sound ones. In plants which conceal the germ of destruction we find slight traces of the fungous threads only in the nodes and in the growing points, and in the latter they do not attain further development until the ovaries are formed. They then proceed to the formation of spores in this place only, not in the leaves, where they remain sterile and do not produce a single smut spore. The ovaries swell mightily with the rapid and abundant development of the fungus in them, and finally, like the horns of ergot, grow to be many times their natural size, projecting far out of the panicles. Finally, after the complete spore formation of the fungus, they break up and allow the spores to dust away. In this stage scarcely a trace of the mycelium of the fungus is to be found in the host plant.

The behavior of corn smut is directly opposed to that of the smut forms which inhabit the grain exclusively. This form can produce its smut beds on any part of the host plant, and in the strange and repulsive similitude of cancriform swellings and ulcers.

For infection experiments with smut germs the big corn plant is an ideal object. All parts of the maize, from the seedling to the inflorescences and fruit-spikes, are developed on a large scale, and are easily accessible for each form of the experiment. The corn smut itself, *Ustilago maydis*, is also a smut form especially suitable for the infection.

C. I began infection experiments with corn smut in the spring of 1885. The spores of *Ustilago maydis* do not germinate in water, or do so very sparsely only after some years. In nutrient solutions they germinate without exception and immediately. They are therefore consigned to nutrient solutions or nutrient substrata, and not to mere water, for full germination. They produce an endless quantity of sprout conidia, and still more rapidly than the two forms of Ustilago previously mentioned, *U. carbo* and *U. cruenta*. The conidia are thrown down as a white, granulous precipitate, which appears even whiter than the sediment of *Ustilago cruenta*. But in this case the sprouting of the conidia takes place *upon* the nutrient solution, where mold-like pellicles are formed, from which the conidia can easily dust off through the air.*

I. In the first series of experiments, in 1885, I infected only young seedlings in different stages of germination. In more than ten distinct sets of experiments the seedlings were copiously sprayed with conidia and were afterwards set out in the field.

After 16 days, very scattering signs of smut were visible among the plants which had been infected in the earliest stage of germination. Below, upon the axes, a smut swelling was developed, in consequence

* This formation of sprout conidia in the air is likewise peculiar to a number of other *Ustilagineæ e. g.*, *Ustilago bromivora* and *Ustilago destruens*, also *Tolyposporium junci*, etc.

of which the plants died. The loss, however, was trifling, amounting to only 4 or 5 per cent. The seedlings which were infected in later stages gave only 1 or 2 per cent of loss. The last set, with open sheath, remained sound.

The few plants which became diseased so early, and which died completely, suggested in their appearance the smutted maize seedlings which Kühn observed and described. The time of the appearance of the smut swellings after the infection also agreed with Kühn's statement.

I now waited, expecting that, as had happened with oat and millet smut, the corn smut would appear upon the fully developed plant, especially in the fertile spikes, but I waited in vain. Already, the fact that, from this time on, the strongly developing axes remained entirely sound had made me suspicious, and when autumn came, and the ears were formed, *not one out of many hundred plants was smutty.*

Before the issue of this experiment, which had consumed several months, I stood at first helpless. The infections were made as carefully as possible, and the failure was not to be explained by these. This must have other causes. All reflections in the course of the winter led me back to this conclusion, *that probably in maize the infection of young seedlings could not lead to the production of smut in the full-grown plant*, as is the case in smut forms living in the grain. At the time of this first series of experiments, in the year 1885, I still held to the old view, universally current until now, that smut germs generally could penetrate only into the young seedlings in order to appear later as smut beds in the full-grown plant, and that, consequently, a penetration of the germ into the plant when it had passed the seedling stage was not possible. I had not then tried infections in the heart of full-grown plants. In the failure of the infections with the corn seedlings I first found the suggestion for the latter. Gradually I came to the conviction that the view that the fungous germ could penetrate only into the seedling was an embarrassing one; that the seedling consisted only of the young parts of plants, and that, of course, the penetration must occur not exclusively in the seedling but also in all places which were in a young condition similar to the seedling. This applied, first of all, to the growing points, the buds, the heart of the plant which was still growing and forming new tissues overhead. Here, therefore, the infections must be made. These I now prepared for by sowing kernels of corn in long beds, in the open air, at the end of April of the following year (1886).

II. In the first half of June, 1886, the maize plants of a long bed were abundantly infected in the heart by means of a suitable spraying flask. For the most part these plants were about a foot high, and the young leaves of the growing point had formed cornets very suitable for receiving the infection. The plants remained uncovered, as a period of dry weather had set in. The injected fluid containing the sprout germs, which at first covered the growing point, was not to be seen on the following days. The leaves of the tip continued to develop during the

next 10 days normally and luxuriantly. On the twelfth there appeared an etiolation in the heart of the plant, which extended upward as far a the leaves had previously been touched by the injected fluid. In the blanching leaves, the surface of which was strewn with penetration spots, there was an abundant production of mycelium, which had penetrated in all directions. In addition, the commencing hypertrophy of tissue was already clearly visible in the attacked and ever-paler appearing parts. After an additional week, in which the growth of the whole plant, including the parts attacked, had proceeded considerably, the cancroid swellings of the smut pustules reached full development and a size never before seen. The entire leaves were covered with a complete crust of pustule, which in part made them almost unrecognizable; out of all parts of the axis, in fantastic forms like ulcers, the great smut swellings grew luxuriantly, so that the plants in their entirety were deformed and spoiled—a complete picture of disease. Scarcely had the rapidly developed swellings reached full size when they lost their white appearance through internal change of color. The spore formation quickly included the whole densely interwoven mycelial skein inside of the swelling, and the final result was a black mass of smut spores inclosed by the external tissue layers of the host plant, *e. g.*, of the pustule.*

Of all the plants which were infected, *i. e.*, more than a hundred, none remained sound after 4 weeks. The smaller they were at the time of infection, the more they suffered. The extension of the young axis, which was disturbed by the formation of smut and the accompanying hypertrophy of tissue, was afterward completed. Whole plants were wasted and distorted by the fungus into miserable objects. They lay in part upon the earth and perished without exception. On the larger plants the formation of pustules was localized upon the upper parts, the only ones attacked. The lower sound leaves continued to nourish the plants and they did not die. In only twelve of these plants did the injected fluid reach as far as, or penetrate into, the nascent staminate inflorescence. To the extent that this happened the parts soon became smutty, sometimes the tips only, and again the lower portions. The glumes and the filaments swelled more than fifty-fold, and in isolated cases became tumors which, by their weight, afterwards bent down the whole panicle. The long series of charts which I have hung up, and which were drawn by my young friend and associate, Dr. Istvanffi, of Klausenburg, will serve to illustrate the most striking cases from these series of experiments.† In the upper part of one of the pictures, in the

* Through this pathological picture of the cancerous tumors on the maize plant we arrive involuntarily at the notion of what the symptoms would be if the smut spores were not black, and were not produced in such masses as happen in the maize, and if the substratum were not a vegetable, but an animal organism.

† These charts, and many others illustrating the life history of smuts, may be found in Dr. Brefeld's *Heften* V and X, to which he desires me to call attention. These are published by Arthur Felix, Leipsic, Germany. Part X, giving *in extenso* the results here summarized, is now passing through the press.—Tr.

attacked staminate inflorescence, there are a number of fertile blossoms the individual ovaries of which reached the size of a walnut, and were still crowned with the base of the style.

On such plants as survived, the appearances of disease diminished after 6 weeks, with the ripening of spores in the pustules, and not long after only the dried pustules remained; aside from these, and the persistent distortions of the upper part of the axis, nothing more was to be seen of the smut. During this time the fertile inflorescences appeared below on the axis, in the axils of the leaves which had remained sound. No smut was to be seen on these, and later they were pollenized from the staminate inflorescences which had remained sound and developed normally. In autumn, a large number of ears bearing sound, ripe kernels were harvested from these plants.

After this conclusion of the series of experiments no doubt could remain that the smut germs develop, and within 14 days, too, in the particular spots of the young parts of the plants into which they have penetrated, and in these only. All parts of the plants which are not touched directly by the germs remain sound, so that sound ears can be gathered in autumn from maize plants which are infected in the heart in summer and which become smutty on all parts that have been touched directly.

But here was still necessary the additional experiment of verification by which it must actually be proved that the fertile inflorescences also become smutty as soon as they come into direct contact with smut germs while still in a very young condition.

III. Again, the next year I had whole beds of maize plants prepared in the field for supplemental infections. I waited for the time when the pistillate inflorescences should begin to appear on the sound plants. These showed distinctly at the end of July, on the third to fifth internodes of the axis, by a swelling of the leaf sheath. As soon as the swelling had reached the point where the otherwise firmly encompassing ligule was pushed up somewhat from the axis, the infection was made by spraying into the leaf sheath so that the injected fluid containing the sprout germs stood even with the rim of the ligule. More than one hundred plants, each of which, as a rule, afterward brought forth two ears, were infected in this way.

The results of the infection were visible at the expiration of 14 days. The leaf sheaths were burst open, and the ears within came to view as a continuous smut pustule. Individual ears swelled to the size of a child's head, and only here and there distinguishable were the peculiarities of the fertile inflorescence, the ovaries of the young ear; otherwise, for the most part, was to be seen a single deformed, repulsive structure. No fertile inflorescence, which was infected when a young bud, remained uninjured. The narrowly local action of the infection could be shown directly on the plants on which the lowest flower buds were infected but not the upper. The latter always remained sound; the former alone were destroyed.

IV. The formation of the pustules in the very young ear did not yet exactly correspond to the appearances which I had formerly seen on fertile spikes, where each ovary had swollen individually into a tumor as big as a nut, so I extended the experiments still further. Ears which already bore silks were somewhat opened at the tip, and only the exposed ovaries of the spike were infected by means of the sprayer, while the lower were not infected. If the presumption as to the narrowly local action of the infection were correct, then in this case also only the upper ovaries would become smutty.

The ovaries behaved with military punctuality. After 16 days the upper ones swelled, and became almost egg-sized smut tumors, as the suspended pictures show. All of the ovaries lower down on the same spike yielded sound, normal grains.

V. There remained only the incipient adventive roots on the lower nodes of the axis as susceptible objects of attack. The beginnings first appear when the growing points and the leaves have reached full size, *i. e.*, when the plants begin to elongate. They appear in a ring around the nodes near the ground; the farther up they are the shorter they remain, and then, generally, they do not penetrate into the earth.

As soon as the tips of the roots were exposed, the infections were made by spraying with the atomizer, and then a shelter from rain was placed over the roots. Once more, after 3 weeks, individual root tips showed swellings of the bigness of a nut on their ends, which meanwhile had elongated. These swellings developed into normal smut pustules, as shown in this sketch.

VI. To round out the experiments, the silks which hung far out of the fertile inflorescences were also infected by spraying. Here the infection had no result, as was to be expected. The silks remained unchanged, and their spikes, which were protected from the infection, also remained entirely sound. The silks, indeed, are no longer young tissue. The fungous germs still penetrate occasionally, but do not develop, because the luxuriant growth of tissues necessary for the formation of pustules is excluded.

VII. All infection experiments made by spraying into the heart of the plant when the sterile inflorescences were already visible in the growing points, were also without results. Penetration spots were still to be found, and also fungous threads in the superficial tissues. Externally on the leaves a slight shrinking was also observed on isolated spots, but they recovered because the fungous germs found in the already too old tissues no suitable place for the production of smut beds. I have already referred to the fact that penetration itself is impossible in still older parts of the maize plant which have reached nearly full growth.

According to this, the final result of all the infections with corn smut on maize is entirely different from the previously described results with smut fungi living exclusively in the grains. The smut germs come to

full development and produce smut pustules and spore beds on every spot of the still undeveloped parts of the plant into which they have penetrated. The action of the germ is narrowly localized—only those parts of the young plant become smutty which have been attacked directly by the fungous germs; all the rest remain normal and sound. The formation of the smut pustules begins quickly, at longest, 3 weeks after the infection.

The complete result of all the here-cited infection experiments with dusty smut, millet smut, and corn smut affords, in the first place, indisputable proof that the germs of smut fungi which live saprophytically outside of the host plants can produce smut diseases.

When the smut was nourished saprophytically longer than a year in continual reproduction outside of the host plant, then only did the outgrowth of the conidia into germ tubes cease. Along with this the power of infection was extinguished, *i. e.*, with the disappearance of a comprehensible morphological character, for the germs can only penetrate into the host plants by means of their germ tubes.

The earlier view that only young seedlings of the host plants are receptive to the fungous germ has not been sustained. On the contrary, the fungous germs can penetrate into all sufficiently young parts of the host plant.

In the grain-infesting smut fungi, *e. g.*, in the dusty smut and millet smut, of all the fungous germs which have penetrated into the young parts of the plant, of course, only those come to maturity, *i. e.*, to the production of smut diseases, which reach the growing point and the place of the here-included nascent inflorescence. This takes place only in the germs which have penetrated into the young seedling in the vicinity of the root nodes during the first stage of germination. For all the other germs which have penetrated later this is already impossible. The vegetative tips with their incipient blossoms, the later place of development of the smut, have already grown away from these, and consequently are entirely out of reach inside of the plant.

The relative rapidity of germination in plants receptive to smut diseases aids materially in determining the subsequent appearance of the smut, *i. e.*, the development of the germ which has penetrated. This may vary according to the accidental temperature prevailing at the time of germination, therefore according to external influences; but from internal causes it will also be dissimilar in particular individuals, which accordingly may show an individually different receptivity.

In the peculiarities formerly stated, and now clearly established by me, the natural explanation is given, so far as regards smut diseases, to the terms "periodic receptivity," "subsequent immunity," and "individual predisposition to an infective disease."

Especially noteworthy is the long incubation period from the penetration of the fungous germ to the outbreak of the disease. The germ of the destructive disease is taken up in the earliest youth of the plant

and first comes to destructive action when the latter is sexually mature. Here we have a case of "definite periodicity in an infectious disease" explained clearly and naturally by actual peculiarities. The disease germs remain latent, and traces even are scarcely to be found. The attacked individuals are even stimulated in their growth, and are in advance of the sound ones—until suddenly at the time of sexual maturity the disease germs, hitherto concealed within, come into destructive operation.

In smut fungi, which do not live exclusively in the grains, but also appear and form smut beds in other parts of the plants, *e. g.*, in corn smut, the infection remains local. The fungous germs proceed to the development of smut in the sufficiently young parts of the plants only on those spots into which they have penetrated. The plants are receptive to the infection as long as young parts are being produced on them. Only when this is no longer the case, *i. e.*, when the plants are full grown, does the stage of immunity begin. To what extent the peculiarities in the smut fungi and smut diseases, which are now explained, may be of value for judgment upon similar occurrences in infectious diseases, especially in pathology, is self-evident.

In conclusion, I may be permitted to observe that seven years' labor was necessary to reach the conclusions on smut fungi and smut diseases given in my first address four years ago, and in this present one. The substance of this address is here made public for the first time as original work.

RIPE ROT OF GRAPES AND APPLES.*

By E. A. Southworth.

Plate XVI.

HISTORY OF THE FUNGUS.

Judging from the bibliography of the fungus of ripe rot and from the very scant specimens in the herbarium, it seems to have received four or five distinct names at the hands of three or more investigators. The fact that it varies greatly in its microscopic and external characters probably accounts for the vicissitudes of nomenclature through which it has passed, and for the fact that one authority has given it two and perhaps three names.

In 1854, M. J. Berkeley described and figured in the Gardeners' Chronicle a disease of the grape caused by a fungus to which he gave the name *Septoria rufo-maculans*. He describes the fungus as attacking ripe fruit and causing considerable destruction. From his figures and general description there is little doubt that the fungus is the same as

* *Glœosporium fructigenum*, Berk.

the one which is the subject of this paper. Later he changed the name to *Ascochyta rufo-maculans*, and it is described under the latter name in Saccardo's *Sylloge*, although Von Thümen in Fungi Pomicoli calls it *Glœosporium rufo-maculans*.

In 1856, in the same journal, Berkeley described and figured a fungus on apples under the name of *Glœosporium fructigenum*, and said:

> It was impossible not to call to mind the little fungus figured upon grapes, * * * and the subjoined figure compared with the one there given would at first seem to indicate an identity. But the spores were more inclined to be curved, rather longer, and not so variable in size, and the want of a perithecium separated the two widely from each other. * * * I would not affirm that the two productions are essentially different, and the more especially because in external appearance and habit they are so perfectly identical.

In the Gardeners' Chronicle for 1859 Mr. Berkeley describes a fungus on peaches and nectarines, *Glœosporium lœticolor*, as new to science. The description is not accompanied by figures, and it varies in some important points from that of the two preceding fungi, but in closing Mr. Berkeley says:

> A plant of the same genus destructive to apples is figured and described in this journal. We may also refer to the very similar production on grapes.

As we possess no specimens of *G. lœticolor* it is impossible to draw any conclusion as to whether this is or is not the same as *G. fructigenum*, but it does not seem impossible. The chief points of variation may be accounted for by the change of host.*

Still another fungus, or the same fungus under another name, was described by Berkeley and Curtis from South Carolina in Grevillea, in 1874, as attacking apples. They give it the name *Glœosporium versicolor*, and remark that "it is very different in habit from *G. fructigenum*, which also occurs on apples."

It is to be noted, however, that the specimen from which Berkeley described *G. fructigenum* was kept in the house, and if this was not the case with the fruit from which the other fungus was described there is a wide chance for variation, especially in a fungus which varies greatly even under the same conditions.

The herbarium of the Department gives very little aid in reaching any decision as to the identity of these fungi. There is one specimen labeled *G. fructigenum*, from Newfield, New Jersey, on rotting pears, but I am not sure as to the authority for its identification; and another of *G. versicolor*, from Delaware, which was distributed in Ellis and Everhart's North American Fungi, No. 1897, on apples. From a comparison of the two specimens there seems to be no doubt that they represent the same fungus. Of course it is impossible to form a decision which would be of any value from these premises, but it is evident that the

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* W. G. Smith has recently figured a fungus on grapes which he calls *G. lœticolor*, and which from the figures seems to be the same as the *G. fructigenum* of this article.

descriptions given, if they do represent different fungi, are not sufficiently accurate to give us any criterion of identification.

In the Annual Report for 1888 Mr. Galloway described a fungus causing the bitter rot of apples, which he identified as Berkeley's fungus *Glœosporium fructigenum*, and which agreed closely with the herbarium specimens.

In the summer of 1888 Prof. F. L. Scribner found what he supposed to be a new fungus on the grape in the Department grounds. He examined it, but as its similarity to bitter rot of grapes threw some doubt on its specific value no further observations in regard to it were made. In the following season it was found again by the writer, and since then it has come to the Department from several sources.

A study of its structure at once suggested a close relationship with the fungus causing bitter rot of apples, and also with the one causing the bitter rot of grapes. It differs from the latter, however, in several points.

Owing to its similarity of form with bitter rot of the apple, a series of experiments was undertaken to ascertain whether or not the two were identical. Living spores of the grape fungus were inserted under the skin of healthy apples by means of a flamed knife, and other apples similarly punctured but not having the spores inserted were used as checks. At least twelve apples were thus infected, each apple being infected at three points. In every case but one the fungus developed, and with but one exception at all of the infected points. The one exception was where spores were used which a few days later were found to be incapable of germination. In case of another apple, spores were purposely used which were supposed to be past the power of germination. The result was that the fungus developed at one point of infection only, and this was probably the result of carelessness, as the knife was not flamed after being used to infect an apple with spores from another grape, and the spot into which the knife was first pushed received some of these spores that were capable of germination. None of the checks developed the fungus. The rot spots began to appear in about 3 days, and pustules made their appearance in from 5 to 8 days.

Apples attacked by the typical bitter rot fungus were obtained from Arkansas, and the spores were used for infecting grapes in a manner similar to that described for apples.

The results were not so striking as in the former case, but in a small proportion of the infected grapes typical pustules with spores were developed, and this was not true of the checks. Many of the infected grapes, which did not show pustules, decayed in a manner typical of grapes attacked by the fungus, but grapes were so much harder than apples to preserve from the attacks of saprophytic fungi that in most cases they succumbed to these before the *Glœosporium* had a chance to complete its development. The most successful infection experiments

were made on Malaga grapes, three or four berries out of a dozen developing the fungus, but grapes grown on the grounds were also successfully infected.

The pustules produced by inoculation were exactly like those produced in a state of nature, and the fungus in apples infected with spores from another apple was exactly the same, both as to structure and effects produced, as in apples infected with spores taken from the grape.

These experiments leave no doubt that the fungus found here on the grape is the same as the bitter rot of apples. And from a comparison of Berkeley's figures and description there is very little doubt that it is identical with his *Ascochyta* (*Septoria*) *rufo-maculans*. The strict law of priority might demand that we now make the specific name *rufo-maculans*, but since the better known *G. fructigenum* is also Berkeley's name it will remain so in this paper. It is perhaps well to say that Professor Cavara has kindly compared this fungus with the *Tubercularia acinorum* described by himself and states that the two are distinct.

The proper settlement of the whole question depends upon the comparison of type specimens not accessible to us, and it is hoped in what follows to give a sufficiently full description of the fungus so that others who have these specimens within reach may be able, by comparing them with the figures and descriptions, to decide whether they represent distinct species or not.

The popular name which should be given to the disease on both grapes and apples is nearly as much of a question as that of the scientific name of the fungus. The old term, bitter-rot, so applicable to the disease of the apple, will not do for the grape, as the fungus does not give the latter fruit any bitter taste, and the name is already given to another grape-rot, caused by a fungus, which does impart a decided bitterness to the ripe berry. The term anthracnose is also preëmpted, otherwise that might be used, as this fungus belongs to the same type as others causing this disease. The name ripe rot, which has been finally adopted, may answer the purpose in spite of its lack of euphony, as the fungus attacks neither grapes nor apples until they begin to ripen.

EXTERNAL CHARACTERS.*

On the apple.—The presence of the fungus is first indicated by one or more brown spots somewhere on the surface of the apple. These may not be more than a quarter of an inch across at first, but they spread very rapidly and in time cover the whole apple. The spots have the appearance of ordinary decay except that they are a little sunken, and are apt to be somewhat firmer than is natural where this fungus is not present. Moreover, after the spot has existed a few days, small black pustules make their appearance on the surface. These are often so numerous in the center as to give it a black color, and those nearer

* Colored drawings of the external effects of this fungus will appear in the Annual Report for 1890.

the circumference are likely to be arranged in circles. It not infrequently happens that the pustules are not black at first, especially when the apples have been kept in a moist environment. They may appear quite white before they break through the cuticle, and later the spore masses give them a pink color over the top. Sections through diseased apples show that the tissues are decaying for some distance; and in preparing a partly decayed fruit for eating, great care must be taken to remove every fragment of this discolored tissue, as a scarcely perceptible amount can impart an intensely bitter taste.

On the grape.—The fungus seems to attack only ripe grapes, and when the diseased grape is a purple one no change of color occurs, but the berry decays and the skin seems to be raised up in pustules over the diseased portions. On white grapes the fungus produces a very characteristic appearance. A small, reddish-brown spot appears on the side of the berry; this spreads and becomes darker in the center, so that by the time it has spread over half the berry it has a purplish center merging into a narrow bright-brown border. It is moreover covered with minute pustules which are at first whitish, then exude a flesh-colored powder, and finally become dark brown or even black with age. The berry finally becomes quite dry and shriveled, but even in this condition it does not become black like those attacked by black rot, but may even preserve a translucent appearance. On a few grapes, whose tissues were at the same time hardened by the presence of the mycelium of *Peronospora viticola*, the areas attacked by the *Glœosporium* had sunken in, as is the case with the apple. On the grape the pustules often continue bearing spores, and hence retain their flesh-colored appearance even when the berry is nearly all dried up. The fungus does not communicate a bitter taste to this fruit.

MICROSCOPIC CHARACTERS.

The structure of the fungus is so variable that it is almost impossible to frame a description that will be true under all circumstances.

The appearance of the fruiting bodies differs on nearly every berry that the fungus attacks, although it is a somewhat curious fact that the pustules on any one berry are very nearly alike. The color and shape of the spores are the most constant characters, but the latter varies considerably. In the following description the most characteristic and common variations will be noted, but they by no means comprise all that may be expected even in a short study of the fungus.

The first stage in the formation of the fruiting body is the most constant one. A cushion of stroma forms just below the upper wall in a group of the epidermal cells; as it increases in size the contents and lower wall are pushed downwards, the cross walls are broken or absorbed, and the upper wall pushed upward until it is ruptured and the fungus exposed to the air. As soon as the stroma has attained about 20μ in thickness it can be seen to consist of parallel threads arranged at right angles to

the plane of the epidermis, and containing frequent septa. The stroma mass is colorless at first and shaped like a double convex lens. The hyphæ composing it are adherent along their whole course and may branch. The central portion is often composed of larger, more transparent hyphæ. When the cuticle is finally ruptured the shape of the stroma may change considerably, from the fact that it meets no further resistance to its upward growth. It is also from this time on that the changes which cause the fungus to be so variable take place. Sometimes the free ends of the hyphæ bear spores over the entire surface so that the stroma forms a compound sporophore, but usually the large cells comprising the center of the stroma mass break down, and the entire center becomes separated from the outer portions and may pass out through the opening in the cuticle. In this case spores are borne around the circumference of the stroma and the cavity left in the center develops basidia and spores on its sides, thus producing a pseudo-pcynidium. The amount of the stroma that disappears after the cuticle is ruptured varies exceedingly. In some cases the original mass seems to remain and grow dark colored. In other cases a large amount of stroma still remains, but it becomes dark colored, and enough of the original mass has disappeared so that the spores are borne on a very concave surface. The stroma grows dark colored as soon as the cuticle is ruptured, but the lower part of the central portion usually remains colorless except in very old pustules. In some of these, especially on the apple, it looks as if the stroma had greatly increased in quantity and in a measure at least lost its spore-bearing property. Whether this apparent increase is due to a growth from the base of the stroma has not been directly observed, but from the appearance of the sections this conclusion is almost irresistible, and the fact that the base often remains colorless below the center supports such a view. Examples of this are frequent on the grape, but on the apple the older dark-colored pustules are especially large and after a time seem to stop forming spores. When kept for a long time in a moist environment the ends of the hyphæ sometimes grow out into long dark-colored filaments.

Besides these more common forms there are cases where the stroma almost completely disappears after the cuticle is ruptured, and the result is a typical Glœosporium form, viz, rather long basidia borne on a thin stroma and bearing oblong spores at their free ends. Still another case was found where, instead of a true stroma, the hyphæ were independent down to the very thin, irregular layer of pseudo parenchyma always at the base of the parallel threads; thus forming extraordinarily long basidia with spores at their ends.

Spores.—The spores are unicellular but may become two or even three celled at the time of germination. They are colorless singly but flesh colored in mass, irregularly oblong, sometimes curved and often pointed at one end, or even ovate. They vary greatly in size as well as in shape, and in the case illustrated in Fig. 4 are much longer than

usual. They are apt to be shorter and thicker on the apple, and in dry than in moist surroundings.

Mycelium.—The mycelium is septate and branching, usually colorless, but may become darker colored with age. It is both intra and inter cellular, preferably the latter. In the apple it is sometimes so thick just below the epidermis that it nearly forms a continuous sheet, the threads lying parallel side by side.

The spores begin to germinate in water in about six hours. They swell considerably. The vacuole disappears, but the spore contents pass into the germ tube and the spore is either left partially empty or filled with very thin, slightly refringent protoplasm.

In several germination experiments secondary spores were produced in large numbers. What the conditions were that decided their appearance could not be determined. They were produced both in nutritive media and water, but seemed to be especially numerous where the ends of the hyphæ came in contact with some hard substance like the cover glass, and in two cases the addition of an extra drop of nutritive medium had the effect of stopping their formation. They may be formed on the end of the germ tube when it is no longer than the spore itself, and as the mycelium becomes better developed nearly every branch may produce a secondary spore on its end. They are developed as simple, colorless expansions of the end of the tube, which soon becomes delimited from the rest of the hypha by a septum. The walls become thickened and dark colored, the contents nearly transparent, and a bright spot, strongly refracting, like an oil globule, makes its appearance in the center. The mature spore has a very faint olive tinge and is nearly ovate in outline, being truncate at the smaller end on account of the septum which cuts it off from the hypha. They only retain their original regular form for a short time, the walls soon pushing out in all directions, thus forming a very irregularly lobed body. Sometimes these secondary spores send out a germ tube, and when this happens the bright spot disappears and the spore becomes lighter colored, the contents having apparently been exhausted. More often, however, the mycelium branches just below the point of insertion of the secondary spore, and even in this case the latter sometimes undergoes the changes just described.

The contents of the growing mycelium are at first granular, later becoming more homogenous, and by the time they have reached the stage illustrated in Fig. 7*b* occasional vacuoles make their appearance. Septa are formed soon after germination.

Setæ.—In a few cases brown setæ have been found in the pustules, both on the apple and on the grape, but mostly on the latter. They do not seem to be sufficiently constant or numerous to characterize the species. Where found they are two or more in a pustule, are septate, and of varying length.

Except for the shape and color of the spores this fungus would seem from the description to be identical with that of bitter rot of grapes

(*Melanconium fuliginea*, (S. & V.) Cav.) but there are several points of difference. The spores of bitter rot are navicular and fuliginous, and the stroma is made up of smaller and more uniformly dark-colored cells; moreover it does not seem to be as variable as that of the ripe rot, but there is a more regular disappearance of the upper central portion of the stroma, leaving a cavity the sides of which are always lined with spores and basidia. The formation of secondary spores has never been observed for the Melanconium and the mycelium proceeding from the spore is very different from that of the Glœosporium and is fuliginous. It does seem, however, as if the two fungi ought to be placed in the same genus, but it is not the purpose of this paper to make any changes in nomenclature.

Later stages.—In the Annual Report for 1887 Mr. Galloway described a stage which seemed to be an immature pycnidium. In hopes of obtaining more definite results in this direction, a number of apples which showed numerous characteristic pustules were placed under bell jars in the fall and left until midwinter. When examined, the stages figured in the annual report were found; but in some cases the fruiting body was composed of one outer layer of dark-colored cells, those inside being colorless, and the contents of the central ones broken up into small particles. The structure of the entire body closely resembled that of the immature pycnidia of black rot of grapes, the colorless cells being isodiametric and nearly hexagonal. No spores could be seen, but in one or two cases the contents of the conceptacle were not fully distinguishable, and seemed to be partly composed of radiating lines passing from the circumference to the center. From the top of these bodies arose the characteristic stroma mass, or rather, in this case, a compound sporophore, bearing spores at the free ends of the hyphæ. Still later, one conceptacle showed two asci containing partly developed spores. Unfortunately, the apples were so overgrown with Penicillium and so putrid from the attacks of insect larvæ and bacteria that they had to be thrown away before any more definite results could be obtained.

ECONOMIC NOTES.

The fungus has been known on the apple for a long time, Berkeley's first description of it dating back to 1856. During the past five years it has proved very destructive in certain localities especially in the South and Southwest. One fruit grower from Arkansas reported that from the effects of the rot in the summer of 1887 his orchard of seventy-five trees would not yield 25 bushels. Until the present season only solitary cases have been known of the fungus attacking the grapes, but during the past summer we have received specimens from Connecticut and New York. In the latter State it was observed in Wayne, Cayuga, and Seneca Counties and was found on grapes sent in from the grape-growing district in the southeastern part of the State. It seems to be slowly spreading on the grape, and attacks the fruit often after it is

stored in crates preparatory to sorting. It seems to spread in these large crates, and was found in the most active stage as forming a large per cent of the cullings from the packers.*

Thus far it has been by no means a serious enemy to the grape, but the chief danger for the future seems to lie in the fact that it has proved so formidable on the apple and that the grape can not be considered as safe from its attacks if apples in the vicinity are diseased.

It attacks neither fruit until the ripening process has begun, and with the apple as with the grape may develop and spread after they are packed and stored.

Treatment.—From the foregoing it is evident that it is of great importance to carefully cull all fruit among which the presence of the disease is suspected, as a diseased fruit may infect the healthy ones that lie in contact with it. It has been shown, however, by one experiment, that this disease can be almost wholly avoided by the use of fungicides.

In the summer of 1888 the Department commissioned Mr. Geo. Curtiss, of Stafford County, Virginia, to make a trial of certain fungicides in the prevention of the disease. Mr. Curtiss had repeatedly lost all of certain varieties by this fungus, and his orchard offered a good field for experiment. In order to make the value of the remedies used perfectly clear he left some of the trees unsprayed, and in one case he sprayed only half of a tree, leaving the other half unsprayed as a check. The remedies used were potassium sulphide (one-half ounce to a gallon of water) and the ammoniacal copper carbonate. The sprayings were not begun until August 18 for the potassium sulphide, and August 27 for the copper carbonate, too late in both cases for the best results, as the disease had already made considerable progress. But even under these unfavorable conditions the result was very marked. The apples that were not diseased at the time of spraying were perfectly protected, while the unsprayed trees dropped all their fruit. On the tree that was half sprayed the difference between the two sides was as marked as between the sprayed and unsprayed trees. If the spraying had been done a month earlier it is reasonable to suppose that with proper care in application the rot could have been almost entirely prevented.

Where copper remedies are used for black rot or mildew it is not likely that the grapes are in danger from the ripe rot, and in cases where no remedies have been used, two or three sprayings will probably protect the grapes. For this it will not be necessary to go to the expense of preparing the Bordeaux mixture, but the ammoniacal solution or even the potassium sulphide will probably be satisfactory.

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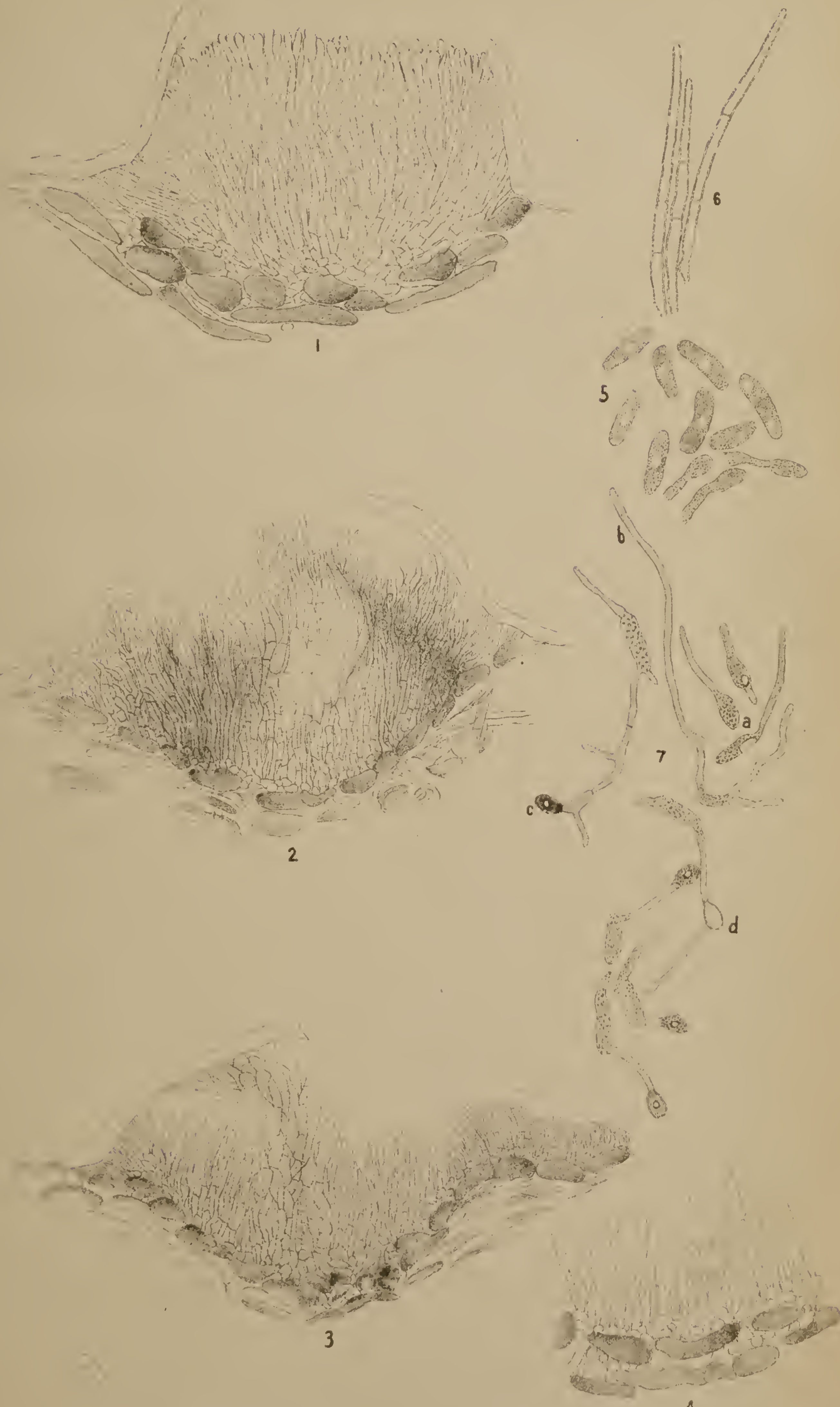
* See Diseases of the Grape in Western New York. Journal. Vol. VI, No. 3, p. 99. Referred to as the Grape glœosporium.



SOUTHWORTH ON RIPE ROT OF GRAPES AND APPLES.

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DESCRIPTION OF PLATE.

FIG. 1. Stroma mass broken through the epidermis. Drawn from specimen, soaked in potash, which caused the ends of the hyphæ to swell and the spores, if there were any, to fall off.

FIG. 2. A later stage. The central part of the stroma mass has begun to break down and spores to form around the circumference.

FIG. 3. Still later stage in the same process.

FIG. 4. Glœosporium form of fungus.

FIG. 5. Spores; three on basidia.

FIG. 6. Setæ.

FIG. 7. Germinating spores; some producing secondary spores on hyphæ.

ANTHRACNOSE OF COTTON.*

PLATES XVII, XVIII.

By GEORGE F. ATKINSON.

While investigating the disease of cotton popularly called "black rust" and "red rust," I found upon an old leaf scar of a cotton stalk a fungus, the spores of which in mass are of a roseate tint. The spores were produced in small clustered heaps, which at length broke through

* Paper read before the American Association of Agricultural Colleges and Experiment Stations. Champaign, Ill., November 11–13, 1890.

to the surface. The fungus resembled very closely members of the genus *Glœosporium.* Farther investigation showed that older specimens possessed olive or dark-brown setæ, intermingled with the colorless basidia. The setæ are proportionately few where the substratum is soft, more numerous when it becomes hard or in the dead or nearly dried parts of the plant, particularly on the stems and the dissepiments of the open boll. The presence of setæ shows the affinity of the fungus with the genus *Colletotrichum.*

On the green bolls the fungus produces depressed spots, at first of a black color, caused by the death of the tissues. If the weather is favorable for the development of numerous spores the dark depressions later assume a grayish or roseate tint from the lesser or greater mass of spores developed. Sometimes the depressions are not well marked, but the fungus being evenly distributed gives a black color to a large portion of the surface of the boll. A severe attack seems to hasten a premature partial opening of the boll, but frequently this checks the growth and the lint can not escape. In such cases the fungus frequently grows also on the lint. Besides these characteristic effects on the boll, the fungus severely injures other parts of the plant. It is a very common accompaniment of *Cercospora gossypina*, Cooke, and other fungi of "black rust" on the leaves, and does much to aggravate that disease. So early as August 12 I found it upon the leaves, and it probably occurred earlier.

The *Colletotrichum* also occasions a very distinct and destructive disease of the cotton plant. A remarkable example of this occurred on the Station farm in some cotton planted in "checks," *i. e.*, in hills with the rows running both ways. The portion of the field attacked was about 2 or 3 acres in extent. During August I noted on my weekly visits that the usual fungi of "black rust" and "red rust" were present, but not sufficient in extent to do any appreciable injury nor to characterize these diseases as they are known to the farmers of Alabama. I found also the *Colletotrichum* principally on the edges of the leaves. In September the *Colletotrichum* severely attacked the stems of the upper part of the plant. The leaves soon appeared, as some expressed it, as if they were affected with a "scald," changing to various shades of yellowish or leaden green color. They soon withered and dried much as if killed by frost, presenting a decidedly different appearance from leaves killed by black rust. The stems became blackened and the death of the plant usually followed.

I have observed the same characteristic disease in several localities around Auburn, but this patch of 2 or 3 acres is the largest I have met with. It is not improbable that in some of the cases reported as "black rust," where in the first stages of the disease it sweeps rapidly and suddenly over certain spots, the *Colletotrichum* is the ultimate factor in causing the death of the plant, and then frequently continues the disease upon the bolls.

Characters of the fungus.—The spores are oblong, usually rather sharply pointed at the base, often rounded at both ends, with a broad shallow constriction in the middle, nearly cylindrical or distinctly curved, sometimes "binucleate." They vary greatly in size from 4.5 to 9μ in diameter by 15 to 20μ in length. Where they are produced on green or decaying bolls, or other softened parts of the plant the distinct acervuli are 100 to 150μ in diameter. On the leaves the acervuli are much smaller and very rarely in sufficient quantity to give the roseate tint. I have found one case of the fungus on a cotyledon of a young plant where the color was distinctly produced. The cotyledons, however, are much more succulent than the leaves. It had also been raining for several days, so that the diseased part could not dry and thus check the profuse development of spores. Many of the spores are borne on scattered fertile hyphæ within the tissues of the leaf, not being collected into distinct clusters. As the tissues of the plant become harder by the partial drying of the leaf the spores produced are fewer in number and borne mainly upon the ends of the setæ.

The setæ are olive or dark brown, straight, curved, flexuous, or rarely branched. They arise from especial bodies, resembling somewhat an imperfect sclerotium, composed of a single dark-brown cell or of a varying number of dark-brown cells, generally a few. When of several cells it is irregular in shape. It is situated within the tissues of the host or projects slightly above the surface or lies along between the cells of the epidermis. When the body consists of a single cell it is produced at the end of a hypha, but is greater in diameter. These single cells may increase to the several-celled sclerotia by a process of growth similar to budding, except that the cells thus formed remain in a closely compact body. The end cells of the setæ are nearly hyaline. The spores borne upon them are often oval, the base being rather sharply pointed. The setæ vary in length from 100 to 250μ. They are usually decidedly shorter on the leaves than on the other parts of the plant. They are in clusters of 5 to 10, or more. Frequently the clusters are so numerous as to make it appear that the setæ are evenly distributed over the substratum.

Artificial cultures.—A number of artificial cultures were made to trace the development of the setæ and the peculiar bodies which bear them. The nutrient medium in most cases was agar peptone broth and an infusion of cotton leaves. Pure cultures were obtained by placing bolls on which the spores were just being produced in a moist chamber. When the cluster of spores was well elevated and distinct, not so old as to be contaminated with bacteria, with a flamed needle a few spores could usually be taken not accompanied by other germs.

The cultures were made in cells. The spores germinated quite freely within 12 to 15 hours, possibly much sooner under favorable conditions. At the time of germination, or prior to it, frequently one or two transverse septa are found in the spore, dividing it into two or three cells.

Several germ tubes may be produced from a single spore. The mycelial threads begin to branch immediately and are somewhat flexuous in their course. From all parts of the mycelium short fertile branches soon arose of 1, 2, or 3 cells' length, which resemble the basidia and produce spores. Sometimes these fertile branches or basidia arise directly from the spore. In the solid medium the spores from a single basidium, when not crowded by the basidia and other spores, are clustered around the end. Each succeeding spore pushing the one which has just become free to one side. The sharply pointed basal end of the spore favors this. After several days there is a beautiful crown cluster of spores about the end of the basidium, all lying parallel to each other. Spores are sometimes produced within 24 hours from the time of sowing.

Besides the production of spores, certain of the branches, either near, or remote from, the center of growth, produce at their ends peculiar enlarged cells, olive brown in color, varying in their outline, but always of greater diameter than the hyphæ which produce them. These bodies frequently produce immediately a normal hypha resembling the others of the mycelium. This in turn may soon produce another special cell, or may grow to considerable length, produce basidia and spores, or as a basidium or fertile hypha direct from the special cell produce spores. In other cases the special cell immediately begins to bud in an irregular manner, producing cells similar in color but very closely compacted into an irregular oval or elongated or flattened imperfect sclerotium. After one or two weeks' growth a large number of these special cells and imperfect sclerotia are produced near the center of growth, *i. e.*, original spore. At the same time the basidia have become very numerous at this point, arising from the mycelium or by the branching of the older ones, and the mass of spores assumes the roseate tint. In several cases I have been able to have the production of the dark-brown setæ borne on these special bodies or cells in the artificial cultures.

Cultures were also started in pure water and in a weak nutrient medium. In water the germ tubes, almost invariably, when once or twice the length of the spore, produced the special cell. If these produced another tube it was only to give rise to another cell of the dark color. In no case were spores produced nor any appreciable length of mycelium. In the weak nutrient medium the special cells were produced freely. Also a number of hyphæ produced one to four or five spores. While the vegetative growth exceeded that of the spores sown in pure water, there was but little compared with the growth in a rich nutrient medium, and the spores did not seem to live long.

These special dark-brown cells, produced soon after germination more freely in weak nutrient media, remind one of secondary spores, but the fact that they are produced in rich nutrient media when ordinary spores are abundant, and especially since they grow by an irregular process of budding to cellular bodies resembling sclerotia, and in both cases

produce setæ, seems to favor the notion that they may serve as peculiar resting bodies produced more abundantly in unfavorable conditions, and later capable of producing mycelia again.

I have observed these same peculiar cells preceding the formation of sclerotia, and intermingled with them in the case of *Vermicularia circinans* on the onion. This is additional testimony regarding the close relationship existing between some of the species of *Colletotrichum* and *Vermicularia.*

Parallel with the artificial cultures, inoculations were made of seedlings grown in a frame. A portion of a boll containing a profuse development of spores was immersed in distilled water which was then shaken thoroughly. The cotyledons of the plantlets were well wetted with this. A bell jar was then placed over them for twenty-four hours. An attempt was then made to imitate as nearly as possible the natural conditions of temperature and humidity, which seem to favor the early development for a few days. By artificial heat temperatures ranging from night to midday, 20° to 35° C. were produced. The humidity of the air in the frame was also kept above that of the open air by keeping the frame closed, having but little ventilation and wetting the soil daily. After the fourth day the humidity was reduced while the temperature was maintained. It was not found necessary to inoculate at incisions in parts of the plant.

A week later an examination was made of a cotyledon which was dying, the distal end being half dead and shriveled while the base was still green. It was well infected, and there were numerous clusters of setæ at the edge, also clusters of spores, and in the interior of the cotyledon spores borne on scattered basidia. Ten days from the time of inoculation another plantlet was diseased, both cotyledons being affected. When the distal half was pretty well dead and shriveled the examination was made. Very few external signs of the fungus were present, but in a few places at the edge the setæ were just piercing through, and sections showed numerous spores and clusters of the special bodies which bear the setæ. The base of each cotyledon was apparently healthy and each was still firmly attached to the stem.

I have not yet attempted to inoculate the plants in any other way than through the cotyledons, but the success attained has suggested that perhaps the plants when not injured in any way are only liable to infection through the cotyledons as in the well-known cases of *Cystopus candidus* in different species of *Cruciferæ.* How far this is true must be determined by future experiments.

The *Colletotrichum* on cotton seems to have been hitherto an undescribed species. Since completing this work thus far I found that Miss E. A. Southworth had been giving the fungus some study, having had specimens of it on cotton bolls. She has proposed the name *Colletotrichum gossypii*, n. sp., which is eminently appropriate.

DESCRIPTION OF PLATE.

Fig. 1. Spores showing variation in shape and size.
2. Spores germinating in artificial cultures.
3. Farther development.
4, 5, 6, 7. Spores germinating and some of the hyphæ producing the dark-brown cells.
8. Spores germinating in pure water, producing immediately the special cells.
9. Spores germinating in weak nutrient medium producing special cells and a few spores.
10. Same.
11. Growth from one spore in rich nutrient medium 65 hours from time of sowing, showing crown clusters of spores around ends of fertile hyphæ; one of the special cells by budding has produced an imperfect sclerotium.
12. Ends of hyphæ in an old culture showing special cells and one seta.
13. Section through acervuli on boll.
14. Same, more highly magnified.
15. Section from stem showing special cells and imperfect sclerotia and origin of setæ.
16. Peculiar enlarged cells from a cluster.
17. Setæ from old specimens on dried part of boll.
18. Setæ from leaf.
19. Young setæ from cotyledon of one of the plants inoculated with spores from a boll.

Figs. 2–12. From artificial cultures, 13 to 18 from natural specimens, 19 from inoculation.

All excepting 13 drawn to the same scale with aid of camera lucida. Fig. 13 drawn with aid of camera lucida to smaller scale.

MYCOLOGICAL NOTES II.

PLATE VII.

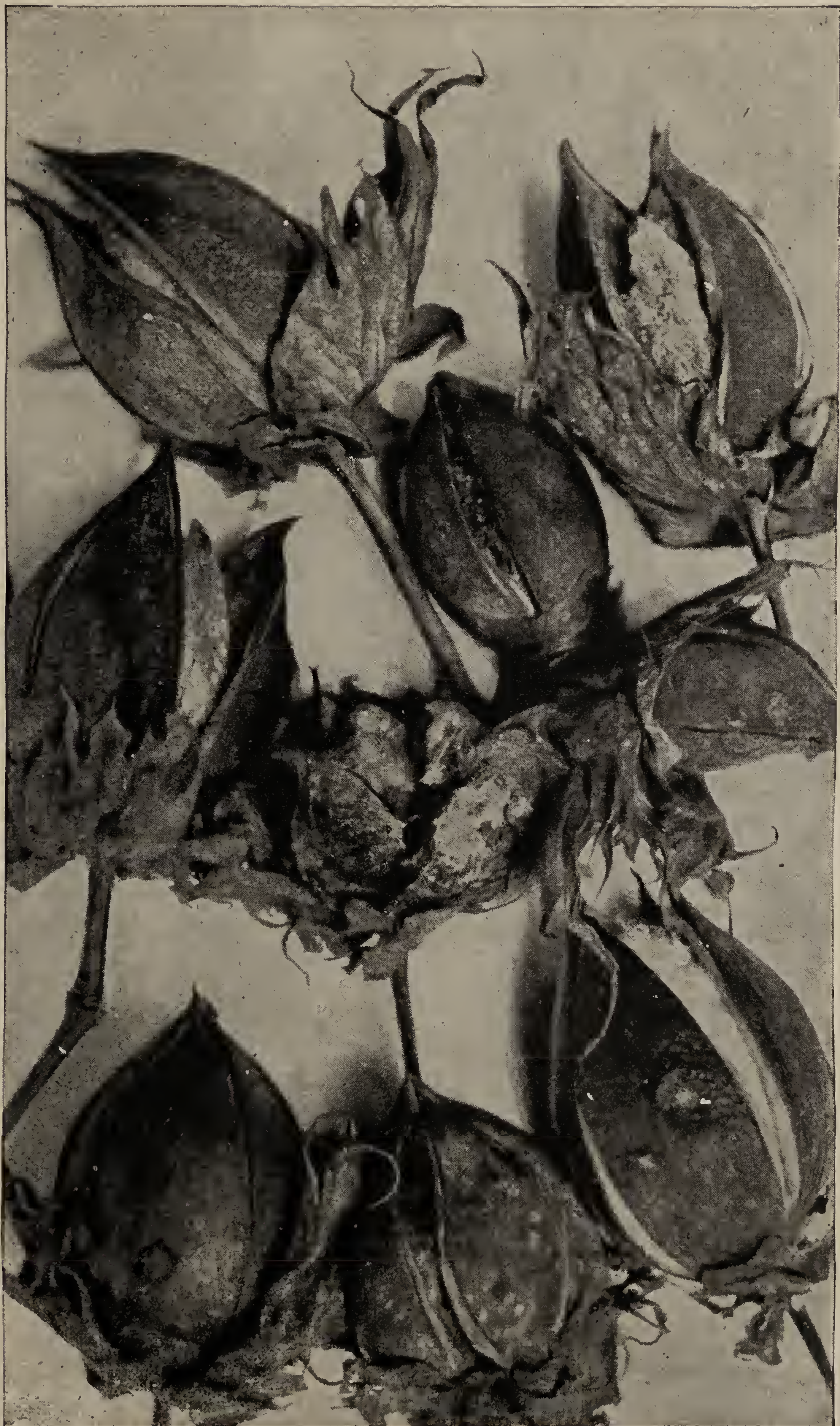
By GEORGE MASSEE.

SARCOMYCES, Mass., (*nov. gen.*)

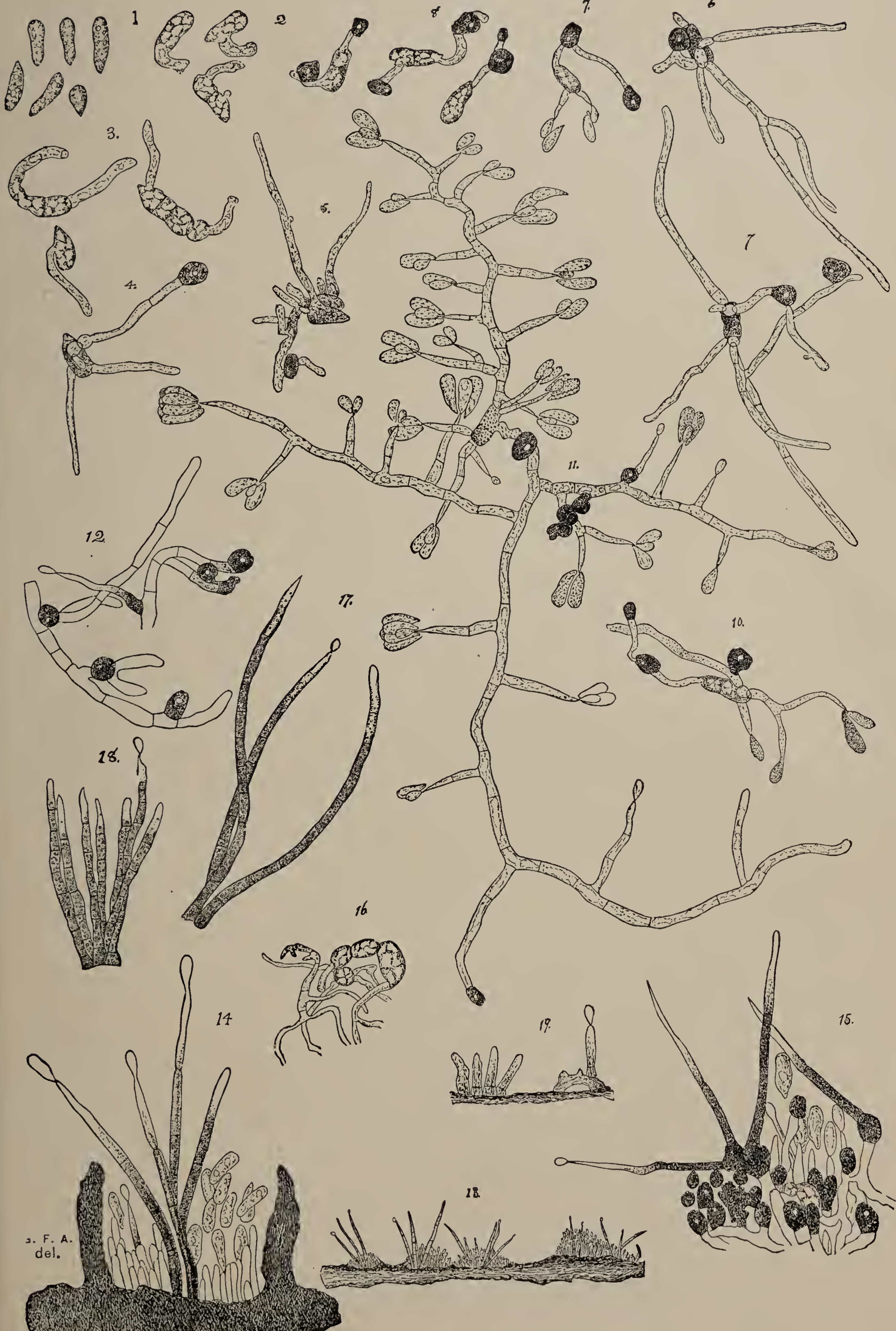
Receptacle subgelatinous, subsessile, erumpent, attached by a narrow base; hymenium convex, even, margin acute; asci cylindrical; spores uniseriate, colored, muriformly septate; paraphyses numerous.

Allied to *Hæmatomyxa*, Sacc., but distinguished by the even marginate hymenium and the uniseriate spores. It is doubtful whether the last-named genus really belongs to the *Bulgarieæ*.

SARCOMYCES VINOSA, Mass. (Figs. 1–3.) Erumpent; substipitate, expanding into a more or less circular fleshy disk, plane or convex below, margin acute, patent when moist, incurved when dry; hymenium convex, even, every part perfectly glabrous and dark purple-brown; asci cylindrical, attenuated and usually curved at the base; spores uniseriate, four in an ascus, elliptical, ends subacute, usually rather oblique, at first triseptate then with septa formed parallel to the long axis of the spore, slightly or not at all constricted at the septa, clear brown,



Atkinson on Cotton Anthracnose.



ATKINSON ON COTTON ANTHRACNOSE.

21–24 by 8–10μ; paraphyses linear, colorless, not incrassated at the tips, aseptate, equal in length to the asci, very numerous, 2–5μ thick.

Tremella vinosa, Berk. & Curt., in Herb. Berk. On wood. Venezuela; S. Carolina, Rav. Type in Herb. Berk., Kew, No. 4285.

From two-thirds to 1 inch across, solitary, or 2–3 in clusters, subgelatinous when moist, cartilaginous and much contracted when dry. With very much the habit and general appearance of *Bulgaria inquinans*, but of a dark purple color.

PEZIZA PROTRUSA, B. & C. (Figs. 8 to 11.) Hypophyllous, gregarious, erumpent, bordered by the torn, upraised cuticle; hymenium plane or concave, whitish, hypothecium very thin; margin of cup slightly raised, composed of parallel septate hyphæ, each terminated by a large, olive-brown cell; asci subcylindrical, 55–60 by 5–6 μ; spores irregularly biseriate, cylindrical, tips obtuse, smooth, colorless, 5–6 by 1.5μ, paraphyses absent.

Peziza protrusa, B. & C., Grev., Vol. III, p. 159.

Pseudopeziza protrusa, (B. & C.) Rehm, Ascom. No. 310. Sacc. Syll. VIII, No. 2980.

Pyrenopeziza protrusa, (B. & C.) Sacc. Syll. VIII, No. 1503. (Type in Herb. Berk., Kew, No. 7815.)

On the leaves of *Magnolia glauca*, Lower Carolina. Gregarious, rarely crowded, up to 0.5 millimetre in diameter. I have not been able to detect paraphyses in the specimen examined. Usually circular and patellate, the irregularity of the opening being due to the mode of rupture of the epidermis.

STAMNARIA PUSIO, (B. & C.) Mass. (Figs. 16–18.) In clusters of 2–3 from a common stem, every part horny and translucent when dry; cups urceolate or subglobose; mouth contracted, externally smooth, even, grayish, or horn colored; hymenium concave, orange, asci cylindrical, slightly narrower at base; spores 8, uniseriate, elliptic-oblong, smooth, colorless, 15 by 7–8μ; paraphyses numerous, linear, septate; the cups pass downward into slender stems which combine to form a thickened, root-like portion.

Peziza pusio, B. & C., Grev., Vol. III, p. 153; Cke., Mycogr. 106.

Sarcoscypha pusio, Sacc. Syll., Vol. VIII, No. 624. (Type in Herb. Berk., Kew, No. 7451.) On the ground. Texas. (C. Wright.)

The whole fungus 1 inch or more high; substance hard and horny when dry; hyphæ thick-walled, densely interlaced, the walls becoming gelatinous and cemented together.

PSILOPEZIA MIRABILIS, B. & C., Journ. Linn. Soc., Vol. X, p. 364; Sacc. Syll., Vol. VIII, No. 616, is synonymous with *Aleurodiscus Oakesii*. Type in Herb. Berk., No. 7402.

CYPHELLA TELA, (B. & C.) Mass. (Figs. 12, 13.)

Gregarious on a dense white subiculum; cups minute, 150–180μ diameter, subglobose; mouth at first small, becoming expanded, but the acute margin always remains more or less incurved; externally

blackish brown, frosted with glistening crystals of oxalate of lime; hymenium concave, even, naked, blackish brown; basidia clavate, tetrasperous; spores subglobose or broadly pyriform, smooth, pale brown, 7 by 5μ.

Peziza tela, Berk. & Curt., Grev., Vol. III, p. 156 (1875).

Tapesia tela, (B. & C.) Sacc., Syll. Vol. VIII, No. 1539.

On wood. Lower Carolina. (Type in Herb. Berk., Kew, No. 7724.)

The present species, owing to its dark color and gregarious habit, also being furnished with a dense, white, broadly effused, superficial mycelium, suggests the genus *Peziza* when examined under a low power, but is a true *Cyphella*.

DACRYOPSIS, Mass., (*nov. gen.*)

Small subgelatinous fungi, fertile portion capitate, sharply defined, terminal on a more or less elongated stem composed of parallel, simple or branched septate hyphæ; at the apex of the stem the hyphæ are very much interlaced, forming a compact expanded layer from which originates in the first instance numerous slender gonidiophores spreading on every side to form a more or less capitate head; gonidia minute, one-celled, forming a dense layer; basidia cylindrical, bifurcate, aseptate, springing from the interlaced layer of hyphæ at the apex of the stem, either contemporaneous with, or later than, the gonidiophores; spores simple or septate.

Coryne, Berk., Grev. Vol. II, p. 33 (in part).

Ditiola, Berk., Ann. Nat. Hist., Ser. 2, Vol. II, p. 267, Pl. IX, Fig. 4.

Tremella, Sacc. Syll. Vol. VI, p. 780 (in part).

Coryne, Sacc. Syll. Vol. VIII, p. 641 (in part).

During the gonidial stage the structure is identical with that of the form-genus *Tubercularia*, the stem is often more elongated than in the last-named genus, but in *Dacryopsis nuda* even this unimportant difference disappears. The basidia and spores closely resemble those met with in *Dacryomyces*, to which genus the present is closely allied, differing in the structure of the stem and in the arrangement and form of the gonidiophores.

The gonidial phase of *Dacryopsis nuda* is morphologically almost indistinguishable from the form species known as *Tubercularia vulgaris*, Tode, but it is well known that the latter is the gonidial condition of the ascigerous fungus called *Nectria cinnabarina*, Fr., hence it is seen that two structures almost indistinguishable in the gonidial form may be conditions of ascomycetous and basidiomycetous fungi, respectively. Again, it is known that the gonidial condition of various species of *Nectria* belongs to such morphologically distinct form genera as *Tubercularia*, *Fusarium*, *Volutella*, etc., consequently it appears to be at least indiscreet to assume, much more to assert, that because a gonidial form presenting certain morphological features has been clearly proved to be a condition of some higher fungus belonging to a given genus that

another gonidial form of similar structure must necessarily be a condition of some hypothetical species of the same genus. Such assumptions do not harmonize with the stated belief of those mycologists who consider that a complete life history is necessary to prove relationship or otherwise in suspected cases, a belief that has brought conviction to the mind of most disciples of the Friesian school, whose conceptions of affinity are based on characters derived from mature examples, which in many instances are of no genetic value. On the other hand, it is to be regretted that the modern school, having adopted the only known reliable test of affinity—life history—should endeavor to indicate affinity from analogy to such an extent as is too frequently done. The close morphological agreement between the gonidial condition in the present genus and in *Coryne* further illustrates the same idea.

DACRYOPSIS GYROCEPHALA, Mass. (Figs. 4–7.) Gregarious or scattered; head hemispherical, plane below, with ridges arranged in a gyrose manner, dark purple, blackish purple when dry; stem equal or slightly incrassate above, smooth, even, pale, tan-colored, 2–3.5 millimetres long, about 1.5 millimetre thick; gonidiophores covering every part of the head, simple, aseptate, straight, 40–50 by 1.5μ; gonidia terminal continuous, colorless, elliptic-oblong, 2.5 by 1μ; basidia projecting beyond the gonidiophores, aseptate, cylindrical, bifurcate near the apex, 60–65 by $6–7\mu$; spores continuous, colorless, elliptic-oblong, slightly curved, with an oblique apiculus at the base, 15–16 by $4–4.5\mu$; clavate paraphyses numerous, shorter than the gonidiophores.

Tremella (*Coryne*) *gyrocephala*, B. & C., Grev., Vol. II, p. 20 (1873). Sacc. Syll., Vol. VIII, No. 2654. (Type in Herb. Berk., Kew.) Lower Carolina. Gregarious, on rotten wood.

The stem attains its full size before the development of the head commences, the latter is at first small and even, but as it increases in size becomes gyrose as in many species of *Tremella* and *Dacryomyces*.

In old specimens the gonidiophores have fallen away, leaving only the basidia and paraphyses.

DACRYOPSIS ELLISINA, Mass. (Figs. 19–21.) Gregarious, head broadly elliptical or elliptic-oblong, smooth, even, pale brown, 4–6 by 2–4 millimetres, stem cylindrical, longitudinally wrinkled, 3–4 by 1.5–2 millimetres, dark brown; gonidiophores covering the entire head, straight, septate, with 1–3 short branchlets near the apex, 40–50 by 2.5μ; gonidia continuous, colorless, elliptic-oblong, very slightly curved, 3 by 1μ; basidia cylindrical, bifurcate at the apex, aseptate, 50–55 by 6μ; spores elliptic-oblong, with an oblique apiculus at the base, 14 by 5μ.

Coryne Ellisii Berk., Grev., Vol. II, p. 33; Sacc. Syll., Vol. VIII, No. 2655. Potsdam, New York. (Ellis.) On decaying basswood log. (Type in Herb. Berk., Kew.)

DACRYOPSIS UNICOLOR, Mass. (Figs. 22–24.) Gregarious; entire fungus, blackish brown; head globose, small, smooth, even, 1.5–2 millimetres diameter; stem elongated, erect, slightly attenuated upwards,

vaguely longitudinally rugulose, 5–8 by 1–1.5 millimetres; gonidiophores covering every portion of the head, linear, curved, septate, with a few short lateral branchlets, 70–80 by 1.5μ; gonidia elliptic-oblong, continuous, colorless, 3–1μ; basidia appearing after the gonidiophores, aseptate, bifurcate at the apex, 45–50 by 5–6μ; spores continuous, colorless, elliptic-oblong, with an oblique apiculus at the base, 15 by 4–4.5μ.

Coryne unicolor, B. & Curt. Type in Herb. Berk., Kew, No. 4310. On rotten wood, Cuba. (Wright.)

I have not seen any previous description of the present species; possibly such may exist along with others of the same genus in some American publication.

DACRYOPSIS NUDA, Mass. (Figs. 25–26.) Gregarious; head hemispherical, flattened below, at first even, then minutely rugulose, reddish orange, 3–4 millimetres diameter; stem short, stout, equal, white, or tinged with yellow, minutely tomentose, 3–4 by 2–2.5 millimetres, even; gondiophores appearing before the basidia, linear, straight, aseptate, simple, or rarely with one or two short branchlets near the apex, 35–40 by 1.5μ; gonidia elliptic-oblong, continuous, colorless, 3 by 1μ; basidia projecting considerably above the gonidiophores, cylindrical, bifurcate at the apex, 55–60 by 5–6μ; spores elliptic-oblong, colorless, with an oblique apiculus at the base, triseptate, 14 by 5μ.

Ditiola nuda, Berk. Ann. Nat. Hist., Ser. II, Vol. II, p. 267, Pl. IX, Fig. 4 (Berkeley's No., 375). Britain. On fir stumps.

Closely resembling in general appearance *Tubercularia cinnabarina*, but quite distinct morphologically.

DACRYOMYCES ENATA, (B. & C.), Mass. (Figs. 14, 15.) Erumpent; dark amber, appressed, surface slightly rugulose or almost smooth, bounded by the ruptured bark, up to 1 centimetre diameter; basidia cylindrical, bifurcate at the apex, 45–50 by 5μ; spores elliptic-oblong, colorless, with an oblique apiculus at the base, slightly curved, 10–11 by 3.5μ.

Tremella enata, Berk. & Curt., Grev., Vol. II, p. 20; Sacc. Syll., Vol. VI, No. 8424. Superficially resembling a small discolored form of *Tremella albida*, but a true *Dacryomyces*. From 3 millimetres to 1 centimetre across. Type in Herb. Berk., Kew, No. 4307. On *Alnus serrulata* and oak, lower Carolina.

TREMELLA VESICARIA, Bull. = *Peziza concrescens*, Schweinitz. (Specimens from Schweinitz in Herb. Berk.)

TREMELLA GIGANTEA, B. & C., Grev., Vol. II, p. 19. Alabama. (Peters.) The present species is a gelatinous lichen. Type in Herb. Berk., Kew, No. 4260.

TREMELLA MYRICÆ, Berk. & Cooke. Foliaceo-gyrose, gelatinoso-elastic, semipellucid, smoky gray, when dry blackish with a tinge of purple here and there, surface with minute, scattered points; spores broadly elliptical, with an oblique apiculus, 8–9 by 6–7μ, colorless.

Tremella myricæ, Berk. & Cke., Grev., VI, p. 133; Sacc. Syll., VI, No. 8422. On bark of *Myrica* and *Persea*, Gainesville, Fla. (Rav.). (Type in Herb. Berk., Kew, No. 4300.)

Forming thin, foliaceous expansions when dry, 1–4 centimetres across. The minutely scabrid surface when dry is characteristic.

DACRYMYCES SYRINGICOLA, B. & C. Erumpent, pale or slightly convex, surface almost even or tuberculated, watery gray or whitish, surrounded by the ruptured epidermis; basidia large, spherical, with four stout, elongated sterigmata, spores colorless, cylindric-oblong, curved, with an oblique apiculus at the base, 32–35 by 8–9μ.

Dacrymyces syringicola, B. & C., Grev., Vol. II, p. 20; Sacc. Syll., VI, No. 8504.

Dacrymyces destructor, B. & C., Grev., Vol. II, p. 20; Sacc., Syll. VI, No. 8505. Both types in Herb. Berk., Kew., Nos. 4324 and 4328.

On *Syringa* and on branches of pear, to which it is very destructive, lower Carolina. Rav.

The only distinction between the two species, as pointed out by Berkeley, depends on the amount of tuberculation of the surface, and even this is not constant. The furcate spores alluded to by Berkley are portions of the septate hyphæ that have become free. Circular or elliptical, often numerous, 3–4 millimetres across, resembling lenticels when dry and contracted.

TREMELLA DEPENDENS, B. & C. Pendulous, elongato-clavate, attached by a slender stem-like base, mucilaginous, pale dingy yellow; the central portion consisting of exceedingly thin hyphæ immersed in mucilage; towards the even surface the hyphæ become thicker and form a compact layer which produces basidia at every part of the surface; basidia spherical with four elongated sterigmata; spores elliptic-oblong, smooth, colorless, 7 by 3–3.5 μ.

Tremella dependens, B. & C., Grev., Vol. II, p.19; Sacc. Syll., Vol. VI, No. 8396. Hanging down from under side of rotten poplar (*Liriodendron*) logs after rain, Alabama. Peters.

The following note accompanied the specimens:

"Sack-like, elongated, round, subclavate, subtranslucent, thin, watery, mucilaginous, dissolving when the thin outer skin is broken, pale, watery, greenish-yellow, $\frac{1}{8}$–1 inch long." The green tinge is due to minute algæ.

TREMELLA RUFO LUTEA, B. & C. A very remarkable form, attached laterally by a broad base, imbricated, resembling *Stereum hirsutum* in habit; more or less reniform or semicircular, margin sometimes lobed, yellow brown or amber, translucent when moist, upper surface irregularly nodulose and with a tendency to form concentric zones due to the arrangement of the nodules, under surface almost smooth; substance thick, very cartilaginous, central portion composed of much-branched hyphæ with thick gelatinous walls; toward the outside, above and below, the hyphæ are dense and parallel, but showing no trace of

differentiation into basidia or gonidiophores. From 4–6 by 3–4 centimetres, and 3–4 milimetres thick at the base, thinner toward the margin. Every portion perfectly smooth. Berkeley's remark "uno puncto affixa," must have been a slip of the pen.

Tremella rufo-lutea, B. & C., Journ. Linn. Soc., 1869, Vol. x, p. 340; Sacc. Syll., Vol. VI, No. 8394.

DESCRIPTION OF PLATE.

1. *Sarcomyces vinosa*, section, natural size.
2, 3. Ascus, spores, and paraphyses of same, X 400.
4. *Dacryopsis gyrocephala*, natural size.
5. Same, X 6.
6, 7. Portion of hymenium and spores of same, X 400.
8. *Peziza protrusa*, X 75.
9. Portion of hymenium and margin of same in section, X 400.
10. Asci and spores of same, X 400.
11. Spores of same, X 1,200.
12. *Cyphella tela*, X 75.
13. Portion of hymenium of same, X 400.
14. *Dacryomyces enata*, natural size.
15. Spores of same, X 400.
16. *Stamnaria pusio*, natural size.
17, 18. Ascus, paraphyses, and spores of same, X 400.
19. *Dacryopsis Ellisiana*, natural size.
20. Section of portion of hymenium of same, X 400.
21. Gonidiophores and gonidia of same, X 1,200.
22. *Dacryopsis unicolor*, natural size.
23. Gonidiophores and gonidia of same, X 1,200.
24. Spores of same, X 400.
25. *Dacryopsis nuda*, natural size.
26. Section of portion of hymenium of same, X 400.

INDEX TO NORTH AMERICAN MYCOLOGICAL LITERATURE.

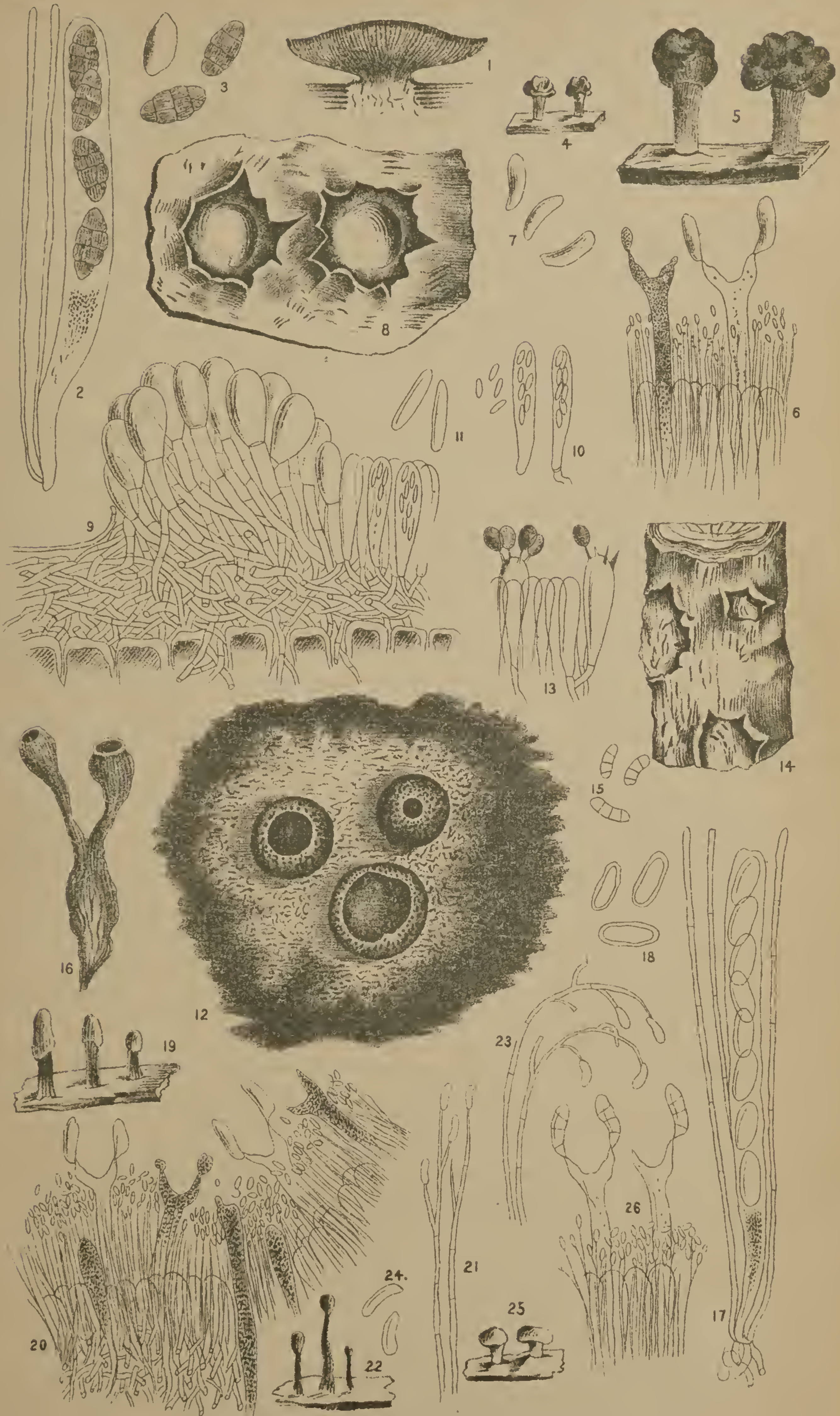
By David G. Fairchild.

177. Anderson, F. W. **Biographical sketch of J. B. Ellis.** Bot. Gaz. Crawfordsville, Indiana, Vol. xv, No. 11, November, 1890, pp. 299–304. Gives an account of the life of this pioneer of North American Mycology.

178. Bailey, L. H. **Peaches and yellows in the Chesapeake country.** American Garden, New York, January, 1891, Vol. xii, No. 1, pp. 20–23. Describes conditions of the disease in Maryland and Delaware. Refers to late investigations of the Division of Vegetable Pathology, showing disease to be of contagious nature not affected by fertilizers.

179. ———. **The peach yellows.** Bull. xxv., Cornell Agr. Ex. Sta. Ithaca, New York, December, 1890, pp. 178–180. Gives account of work of Dr. Erwin F. Smith, of the Department of Agriculture, upon the disease, with note as to the New York State law in regard to the matter.

180. Bessey, Chas. E. **An old botanical letter.** Am. Nat., December, 1890, Vol. xxiv, No. 288, p. 1196. Gives verbatim copy of a letter written by C. H. Persoon to Sowerby, from Göttingen, May 2, 1801, alluding to the latter's "English Fungi."



G.M. del. G. MASSEE. MYCOLOGICAL NOTES.

181. ———. **The host index of the fungi of the United States.** Am. Nat., XXIV, No. 288, December, 1890, p. 1196. Notices work of Farlow and Seymour with word of commendation. (See 126.)

182. ———. **Some bad station botany.** *Ibid.*, p. 1197. Criticises bulletin of Ohio Experiment Station upon wheat smut.

183. ———. **Wheat smut.** *Ibid.* Notices excellent work of Kellerman and Swingle in Bull. 12 of Kans. Ag. Experiment Station. (See 157.)

184. ———. **North American species of Tylostoma.** *Ibid.*, p. 1199. Refers to work by A. P. Morgan upon the revision of the genus *Tylostoma*.

185. ———. **New North American fungi.** *Ibid.* (See 124.)

186. BOYLE, D. R. **A parasitic fungus.** The Microscope, November, 1890, Vol. x, No. 11, p. 343. Note given of discovery at Cape Breton of larva of May beetle attacked by fungus arising from the head. (Name not given.) Specimen sent to Nova Scotian Institute of Natural Sciences by Mr. Boyle.

187. BRAIARD, MAJOR. **Champignons nouveaux.** Revue Mycologique, Toulouse, October, 1890, No. 48, p. 177. Describes *Physalospora pseudo-pustula* (Berk. & Curt.) Braiard & Hariot, (*Sphæria pustula*, B. & C.) on rotten leaf from United States, Farlow, legit.

188. BURRILL, T. J. **Preliminary notes upon the rotting of potatoes.** Proc. Eleventh Ann. Meeting Soc. for Promotion of Agricultural Science, Indianapolis, Indiana, August, 1890. Notes as genetically connected with the rot of Irish potato tubers a species of bacterium, and records its isolation on culture media with inoculations upon healthy tubers.

189. ———. **A bacterial disease of corn** (with fig.). Third Ann. Report of Illinois Ag. Ex. Sta., 1889–1890 (issued 1890). Extract from Bull. No. 6, Illinois Ag. Ex. Sta. Mentions inoculation experiments with pure cultures of bacterium as causing disease, with opinion that the same germs may cause death of cattle when diseased corn stalks are eaten.

190. COOKE, M. C. **Some exotic fungi.** Grevillea, June, 1890, Vol. 18, No. 88, p. 86. Describes *Lizonia sphagni*, n. s., on dead *Sphagnum* from Maine and *Valsa* (*Eutypella*) *clavulata*, n. s., on *Ailanthus* bark. Collected by Mrs. Britton on Staten Island.

191. ———. **North American fungi,** Grevillea, September, 1890, Vol. XIX, No. 89, pp. 14–15. Describes *Cyphella fumosa*, n. s. On rotting leaves of *Gladiolus*, South Carolina, *Rhabdospora sabalensis*, n. s., on *Sabal*, South Carolina. *Stilbum* (*Ciliciopodium*) *aurifilum*, Gerard., on *Dædalea unicolor*, United States, and *Uredo amsoniæ*, n. s., on *Amsonia*, South Carolina.

192. DUDLEY, W. R. **The hollyhock rust** (with fig.). Bull. XXV, Cornell Ag. Ex. Sta., Ithaca, New York, December, 1890, pp. 154–155. Gives popular description of *Puccinia malvacearum*, Mont., suggesting as a remedy permanganate of potash, two tablespoonfuls of saturated solution to 1 quart of water; applied with a sponge.

193. ELLIS, J. B., AND EVERHART, B. M. **The North American Pyrenomycetes.** A contribution to mycologic botany. Bull. Torrey Bot. Club, New York, January 1891, Vol. XVIII, No. 1, p. 31. Give notice of subsequent appearance of the work by placing advance sheets in the hands of the editors of the Bulletin.

194. GALLOWAY, B. T. **Note on the nomenclature of Uncinula spiralis, B. & C.** Bot. Gaz., December 26, 1890, Vol. XV, No. 12, p. 339. Gives correct synonymy of the species, preferring *Uncinula spiralis*, Berkeley & Curtis, 1857.

195. ———. **Some recent observations on black rot of the grape.** *Ibid.*, pp. 60–63. Gives the results of three experiments to prove the relationship between *Phyllosticta labruscæ*, Thüm., *P. ampelopsidis*, E. & M., and *Læstadia Bidwellii* (Ell.) V. & R. Records characteristic *Phyllosticta* spots upon *Ampelopsis* and *Vitis* from sowings of ascospores of *Læstadia Bidwellii* (Ell.), V. & R., and entirely negative results from all sowings of pycnidia spores. (See 130.)

196. ——— AND FAIRCHILD, D. G. **A comparative test of some of the copper preparations in the treatment of black rot of grapes.** Proc. 11th Ann. Meeting Society for the Promotion of Agricultural Science, Indianapolis, Indiana, August 18, 19, 1890, pp. 59, 60 (issued December, 1890). Give result of experiments in Virginia to test comparative efficacy of Bordeaux mixture, ammoniacal solution of copper carbonate, copper carbonate in suspension, and combination of Bordeaux mixture and ammoniacal solution of copper carbonate, three treatments of the former, five of the latter. Conclude Bordeaux to have saved the largest per cent of fruit, but ammoniacal solution to be most economical.

197. GARMAN, H. **Some strawberry pests; the strawberry leaf-blight fungus.** Bull. 31, Kentucky Ag. Ex. Sta., December, 1890, Lexington, Kentucky, pp. 3–13. Describes disease with figures giving results of careful experiments with Bordeaux mixture, eau celeste, liver of sulphur, and London purple as preventives. Concludes Bordeaux, applied at intervals of two weeks after removal of berries, most effective in prevention of *Ramularia Tulasnei*, Sacc., eau celeste standing second, and London purple, although better than no fungicide, standing last. Thinks the removal of diseased leaves in summer, if not followed by fungicidal applications, more injurious than beneficial, because lessening shade to young leaves.

198. HALL, CLIFFORD C. **Stinking smut of wheat.** The Modern Miller, Kansas City, Missouri, October 1890, Vol. 14, No. 9, p. 255 (with fig. from Bull. 12, Kans. Ex. Station). Gives short extract from Bull. 12, Kans. Ag. Ex. Station, 1890. (See 157.)

199. HALSTED, B. D. **Some fungous diseases of the sweet potato.** Bull. 76, New Jersey Ag. Ex. Station, New Brunswick, New Jersey, November 28, 1890 (with numerous figures). Describes, with figures and recommendations for treatment, soft rot, (*Rhizopus nigricans*, Ehr.), black rot (*Ceratocystis fimbriata*, Ell. & Hals., n. s.) soil rot, (*Acrocystis batatas*, Ell. & Hals., n. s.) stem rot, white rot (*Penicillium*, sp.), dry rot, (*Phoma batatæ*, Ell. & Hals., n. s.) scurf, (*Monilochætes infuscans*, Ell. & Hals. n. s.) leaf-blight (*Phyllosticta bataticola*, E. & M.), leaf mold [*Cystopus ipomϾ-panduranæ*, (Schw.) Farl]. A very valuable bulletin of monographic nature, to furnish a basis for experimental work upon the diseases of this important crop.

200. ———. **Notes upon Peronosporeæ for 1890.** Bot. Gaz., December 26, 1890, Vol. XV, No. 12, pp. 320–324. Gives notes of abundance, destructiveness, and previous mention in America of the following: *Phytophthora infestans*, DBy.; *P. phaseoli*, Thax.; *Plasmopara viticola*, (B. & C.), Berl & DeT., on *Vitis*, *Ampelopsis tricuspidata*, and *A. quinquefolia*; *P. Entospora*, Schrœt, on *Erigeron Canadense*; *P. geranii*, (Peck) Berl., on *G. Carolinianum*; *Bremia lactucæ*, Regel, on *L. Canadensis*; *P. parasitica*, DBy., on *Cardamine*, *hirsuta*, *C. laciniata*, *Hesperis matronalis*, and outer leaves of cabbage; *P. violæ*, DBy., on *Viola*, sp.; *P. Cubensis* on cucumbers; *P. effusa* on *Spinacea*; *P. Ficariæ*, Tul., on *Ranunculus abortivus*; *P. alta*, Fl., on *Plantago major*, *P. lanceolata*, and *P. Virginica*; *P. obovata*, Bonord. on *Spergula arvensis* found with *Puccinia spergulæ*, DC., a new rust to this country; *Cystopus ipomϾ-panduranæ*, (Schw.) Farl.

201. ———. **A new anthracnose of peppers** (with fig.). Bull. Torr. Bot. Club, Vol. XVIII No. 1, pp. 14–15. Describes as new *Colletotrichum nigrum*, Ellis & Halsted, which attacks and causes serious damage to the fruits of *Capsicum annuum* in New Jersey.

202. ———. **The rot among late potatoes.** Garden and Forest, New York, November 12, 1890, Vol. III, No. 142, p. 551 (1 column). Notes destructiveness in New Jersey in 1890. Recommends spraying with copper compounds.

203. ———. **The root rot of salsify.** Garden and Forest, New York, November 26, 1890, Vol. III, No. 144, p. 576 (1 column). Notes disease of salsify closely connected with bacteria; which bacteria are able to cause rot in the egg plant, sweet potato, white potato, onion, and apple. The germ not isolated in cultures.

204. ———. The cranberry scald (with figs.). Garden and Forest, New York, December 3, 1890, Vol. III, No. 145, p. 583 (2 columns). Gives account of the scald with conditions probably favorable to the development of the disease, as decaying vegetation and stagnant water.

205. ———. The mignonette disease. Garden and Forest, New York, January 21, 1891, Vol. IV, No. 152, p. 33 (half column). Notes destructive case of *Cercospora resedæ*, Fckl., upon hot-house mignonette, recommending Bordeaux mixture as preventive.

206. ———. The potato rot; its nature, and suggestions for checking it in the future (with fig.). Rural New Yorker, New York, Vol. XLIX, No. 2129, p. 771, November 15, 1890. Popular exposition of subject, suggesting remedies.

207. ———. The rots of the sweet potatoes. Proc. 11th Ann. Meeting Society for the Promotion of Agricultural Science, Indianapolis, Indiana, August 18, 19, 1890, pp. 27–28 (issued December, 1890). (Abstract.) Discusses briefly ground rot, soft rot, black rot, or black root, yellow rot or stem rot, and dry rot, giving general characters and results of investigation. Notes *Rhizopus nigricans* as cause of soft rot and *Penicillium* as cause of dry rot.

208. HARIOT, P., AND KARSTEN, P. A. Micromycetes novi. Revue Mycologique, Toulouse, July, 1890, No. 47. Describes *Calosphæria smilacis*, Kars. & Har., on *Smilax* from Ohio, legit Lesquereux. *Cornularia Rhois*, (Berk.?) Karst. *Sphæronema Rhois*, Berk. Syn.? On *Rhois* from Ohio, legit Lesquereux; *Phoma picea* (Pers.) Sacc., var. *chenopodii*, Karst & Har. on *Chenopodium* from Ohio, Lesquereux legit.

209. HOWELL, J. K. The clover rust [*Uromyces trifolii*, (Alb. & Schw). Wint.]. Bull. XXIV, December, 1890. Cornell Univ. Ag. Ex. Sta., Ithaca, New York, pp. 129–139. (with figs.). Note by W. R. Dudley. Gives occurrence, distribution, and injuriousness of the parasite, with careful description of vegetative and reproductive organs and observations on development; also, an account of artificial cultures and infections. Concludes the fungus to be propagated throughout the growing season by *Uredo* spores, which prefer a low temperature in germination, and are genetically connected with the æcidial stage.

210. JONES, L. R. The potato rot and apple scab. Newspaper Bull. No. 2, Vermont Agr. Ex. Sta., Burlington, Vermont, 1890. Popular description of fungi causing diseases, with formulæ for copper compounds and directions for treatment.

211. KELLERMAN, W. A. More about smut of oats. Industrialist, Manhattan, Kansas, January 24, 1891, Vol. XVI, No. 18, p. 69 (1½ columns). Announces the preparation of Bull. 15, Kans. State Agr. Ex. Station to appear subsequently. Records the discovery of quantities of hidden smut in plats of oats, pointing to a too low estimate of injury. Claims for the Jensen hot-water method augmentation of oat crop in excess of that due to prevention of the smut, mentions as promising fungicide, one-half per cent solution of potassium sulphide, 1 pound to 24 gallons of water, leaving seed in the solution 24 hours. Gives as probable loss from smut in Kansas for 1888–'89–'90 a little less than six millions of dollars.

212. ——— AND SWINGLE, W. T. Preliminary experiments with fungicides for stinking smut of wheat. Report of Kansas State Board of Agr. for month ending August 31 (issued October 1, 1890), pp. 5–29, with plate. Reprint Bull. 12 of Botanical Dept. Agr. Ex. Sta., Manhattan, Kansas, August 1890 (issued October 1). (See 157.)

213. LAGERHEIM, G. DE. Note sur un nouveau parasite dangereux de la Vigne (*Uredo Vialæ*, sp. nov). Comptes Rendus, Paris, Tome CX, 1890, p. 728, and Rev. Gen. de Bot., September 15, 1890. Describes *Uredo Vialæ* as a new Uredineæ upon leaves of *Vitis* found in Jamaica near Rockfort. Decides it entirely different from *U. vitis*, Thüm., which is not a fungus. Of special interest as the first recorded *Uredineæ* upon *Vitis*. Name in honor of P. Viala.

214. Lelong, B. M. **Fungous growths.** Thirteenth Ann. Report of Secretary of California State Board of Agr. Supplement, pp. 242–249 (with 1 lith. plate). Gives general description of fungi, quoting from Harkness, California State Board of Hort, 1883, and treats of Shot-hole apricot fungus (*Septoria cerasina*, Pk.) (with fig.), mentioning spread of disease to peach, plum, prune, and even apple and pear trees adjacent to apricots. Suggests various remedies. Pear cracking and leaf-blight (*Entomosporium maculatum*, Lév.) (with figs.), quotes from Galloway's report, U. S. Dept. Agriculture, both as to fungus and remedies. Recommends as most successful remedy applied both for scale and fungus, sulphur 3 pounds, caustic soda (98 per cent) 2 pounds, whale oil soap, 25 pounds made up to 100 gallons. Apple scab [*Fusicladium dendriticum*, (Wallr.) Fckl.] (with fig.), gives summary of description and treatment of diseases in Report of U. S. Dept. Agr. 1887, also results of Professor Taft's Experiments, in Bull. 11, Div. Veg. Path., U. S. Dept. Agr. (See 104.)

215. Maynard, S. T. **Fungicides and insecticides on the apple, pear, and plum.** Bull. No. 11. Mass. Hatch Ex. Sta. Gives results of experiments in which the ammoniacal solution of copper carbonate mixed with Paris green solution injured the foliage and proved ineffectual against the scab (*Fusicladium dendriticum*). Mixtures of Bordeaux with Paris green proved equally ineffectual. Decides plum wart (*Plowrightia morbosa*), to be controllable by use of kerosene mixed with some bright colored pigment and also kept in check by use of Bordeaux. Gives analysis of 10 pounds of grapes, attached to stems and detached from stems, sprayed vigorously with Bordeaux as showing respectively 0.00996 and 0.00031 pound of copper oxide. Thinks Bordeaux effectual in treatment of mildew and "rot."

216. McIlvaine, Chas. **Nature's peasants—Toadstools.** Youths' Companion, February 27, 1890, p. 114 (2 columns with figs.), treats in popular way of edible fungi, giving means of distinction.

217. Pammel, L. H. **Some fungus root diseases.** Proc. 11th Ann. Meet. Soc. for Prom. of Agricultural Science, Indianapolis, Indiana, August 1890, pp. 91–94. Gives general account of root diseases with special mention of a sclerotium root disease of *Helianthus annuus* resembling somewhat *Sclerotinia sclerotiorum*. Records experiment with iron sulphate, copper sulphate, chloride of lime, sulphur, and various fertilizers against cotton-root rot which proved wholly unsuccessful. Suggests rotation of crops as best method of dealing with such parasites.

218. Panton, J. Hoyes. **Smut; its habit and remedies.** Bull. LVI, Guelph Agricultural College, Guelph, December 9, 1890. Describes popularly *Tilletia caries* (bunt or stinking smut), *Ustilago carbo* (common or loose smut), recommending as remedies clean seed, copper sulphate 1 pound to 1 gallon of water, caustic potash, 1 pound in 6 gallons of water, brine, and immersion for 5 minutes in water at 135° F. or for 15 minutes in water at 132° F.

219. Patouillard, N. **Fragments mycologique.** Journal de Bot., No. 10, 1890, describes *Ithyphallus cucullatus*, n. s. on the earth, Cambridge, Massachusetts. From herbarium of W. G. Farlow.

220. Peck, C. H. **Wheat smut and its treatment.** Cult. and Country Gent., Albany, New York, October 30, 1890, Vol. LV, No. 1970, p. 855 (2 columns). Describes in popular language the diseases caused by *Ustilago tritici*, *Tilletia fœtens*, and *T. tritici*, giving extract from Bull. 12, Kansas Ag. Ex. Sta., containing description of Jensen hot-water method of treatment. (See 157.)

221. ———. **Potato rot. Bordeaux mixture.** Cult. and Country Gent., Albany, New York, November 30, 1890, Vol. LV, No. 1973, p. 916 (half column). Replies to inquiry about disease, recommending the Bordeaux mixture as remedy against *Phytophthora infestans*, DBy.

222. PEIRCE, GEO. J. **Notes on Corticium Oakesii, B. & C., and Michenera artocreas, B. & C.** (with plate). Bull. Torr. Bot. Club, New York, December 9, 1890, Vol. XVII, No. 12, pp. 301–310. Clears up the question of the method of spore formation in *Corticium Oakesii*, B. & C., deciding the basidial spores to be borne on basidia which are modified and developed paraphyses whose bristles have become larger fewer, longer, and more erect; and the conidial spores to appear upon similar bristles either before or after the formation of basidial spores. Decides the species of *Corticium* to be distinct from *C. amorphum.* Arrives at the conclusion in case of *Michenera artocreas* that a basidial stage does not exist, or is replaced by the conidial stage, which consists of flask-shaped mother cells containing single conidia and provided with flagellate tips.

223. PIERCE, N. B. **The mysterious vine disease.** Thirteenth Ann. Report California State Board of Horticulture, Sacramento, California, pp. 169–177. Compares the disease with *folletage* and *mal nero*, French and Italian diseases which bear a more or less close relation to it. Gives results of field and laboratory investigations, history of the spread and characteristics of the movements of the disease in California. Decides the malady not to be due exclusively to ordinary parasitic vine fungi, giving various views as to the cause of *folletage* and *mal nero.*

224. REX, GEO. A. **Descriptions of three new species of Myxomycetes, with notes on other forms in century XXV of Ellis & Everhart, North American fungi.** Proc. Acad. Nat. Sci., Philadelphia, Part II, April-September, 1890, pp. 192–196. Describes as new *Physarum tenerum*, Rex, No. 2489, N. A. F., *Trichia subfusca*, Rex, No. 2495, *Trichia erecta*, Rex, No. 2496. Gives variations found to exist in *Didymium eximium*, Pk., No. 2493, N. A. F., and No. 2089, N. A. F., and thinks the two specimens distributed under these numbers referable to the above extremely variable species. Redescribes, on account of inadequacy of former descriptions, *Badhamia lilacina*, Fr., No. 2494, N. A. F.

225. ———. **Notes on the development of Tubulina cylindrica and allied species of Myxomycetes.** Bot. Gaz., December 26, 1890, Vol. XV, No. 12, pp. 315–320. Considers the formative plasmodium and subsequent stages in its relation to the systematic study of the *Myxomycetes*, citing various species to show the constancy of color in plasmodia of the same species. Expresses opinion that the color of corresponding stages of development of individual sporangia from plasmodium to maturity is always the same. Supports this view with observations upon *Tubulina cylindrica*, (Bull.), *T. stipitata*, and *Siphoptychium Casparyi*, Rostfki.

226. SCRIBNER, F. L. **The Entomosporium of the pear and quince** (with figs.). Orchard and Garden, Little Silver, New Jersey, September, 1890, Vol. XII, No. 9, p. 166. Discusses use of the word "blight" for the disease, and, together with popular description and notes on distribution, gives as most effective remedy Bordeaux mixture preceded by early treatments with simple solution of copper sulphate.

227. ———. **Leaf spot disease of the plum and cherry** (*Septoria cerasina*, Pk.) (with figs). Orchard and Garden, Little Silver, New Jersey, October 1890, Vol. XII, No. 10, p. 183 (2 columns). Gives popular description of fungus, with recommendation that copper sulphate be used as preventive.

228. ———. **Fungus diseases of grapevines** (with figs.). *Ibid.* With aid of figures, illustrates characteristics of grape leaf-blight, black rot, and anthracnose upon the leaf, quoting results of experiment in treatment of black rot by the Department of Agriculture. (See 195.)

229. ———. **Bean rust** (with figs.). Orchard and Garden, Little Silver, New Jersey, November, 1890, Vol. XII, No. 11, p. 200–201. With excellent illustrations, describes carefully, in popular language, the life-history of *Uromyces phaseoli.* Recommends spraying with copper compounds and destruction of all infected material in the fall.

230. ———. **Beet Rust** (with fig. from Ann. Rep., 1887, U. S. Dept. of Agr.). *Ibid.*, p. 201. Mentions presence of disease as confined, so far as known, to California. Gives life-history, and suggests as remedies iron chloride in dilute solution.

231. ———. **Powdery mildew of the cherry** (with figs.). Orchard and Garden, Little Silver, New Jersey, December, 1890, Vol. XII, No. 12, pp. 210–211. Describes popularly the life-history of *Podosphæra oxyacanthæ*, recommending as preventive fungicide, sulphuret of potassium, one-half ounce to the gallon of water, applied while warm.

232. ———. **Treatment of anthracnose of the vine.** *Ibid.* (quarter column). Quotes formula for treatment from Le Prog. Agricole, October 26, 1890: Water, 3 gallons; iron sulphate, 7 pounds; copper sulphate, 2 pounds; sulphuric acid, 1 gill. Also, powder made by mixing equal parts of Portland cement and sublimated sulphur.

233. ———. **Rose leaf-blight.** *Ibid.* (with figs.). Gives popular description of *Cercospora rosæcola* and effects upon host. Thinks plants placed where air and light are abundant seldom suffer from the disease.

234. ———. **Beet leaf-blight** (with figs.). *Ibid.* Describes *Cercospora beticola* popularly, and recommends clear and open culture as means of lessening liability to disease.

235. SEYMOUR, A. B. **Rose rusts** (with figs.). American Garden, New York, October, 1890, Vol. XI, No. 10, p. 609. Notices *Phragmidium mucronatum* and *Ph. rosæ-alpinæ*, giving distinctions and life-history. Decides *Ph. mucronatum*, var. *Americanum*, Pk., to be identical with *Ph. rosæ-alpinæ*.

236. STEWART, HENRY. **Cotton rust.** American Agriculturist, New York, December, 1890, Vol. XLIX, No. 12, p. 638 (1 column). Denies popular belief that the disease is in any way connected with the growing of clover, and refers it to the attacks of a fungus (name not given).

237. STOKES, A. C. **A fungous parasite of Diatoms** (with figs. redrawn). The Microscope, January, 1891, Vol. XI, No. I, pp. 24–26. Gives an account of a new genus of fungi (*Septocarpus*) described by Kopf in a monograph, as infecting diatoms in subalpine bog-pools of Norway, and translated by Mr. G. C. Karop in Journal of the Quakett Microscopical Club, London. The species of diatom affected was *Pinnularia*, and the fungus is considered distinct from that attacking Desmids.

238. THAXTER, ROLAND. **The potato scab.** Bull. No. 105, Conn. Agrl. Ex. Sta., New Haven, December, 1890, pp. 3, 4. Gives preliminary report upon the disease which has been proved beyond doubt to be connected, as an effect, with an extremely minute fungus resembling, with exception of a branching character, certain polymorphic bacteria. Records careful inoculation experiments which establish connection between the "deep" scab and the fungus, and gives short account of pure cultures in solid culture media. Mentions work in progress upon morphologically identical fungus found commonly upon refuse material.

239———. **On certain new and peculiar North American Hyphomycetes, I.** (with Plates III and IV), Bot. Gaz., Jan. 15, 1891, pp. 14, 26. Enumerates with valuable notes the American species of the genera *Œdocephalum*, Preuss, as *Œ. glomerulosum* Bull.) Sacc., *Œ. echinulatum*, n. s., *Œ. verticillatum* n. s., *Œ. pallidum* (B. and Br.) Cost. Considering *Œ. elegans*, Preuss, as distinct from *Œ. glomerulosum* and *Œ. roseum*, Cook, as a synonym. Decides *Rhopalomyces pallidus*, B. and Br. and *R. candidus*, B. and Br. to be identical and synonyms of *Œ. pallidum;* and *Haplotrichum fimetarium*, Riess., as also a synonym of the same species. Gives *Rhopalomyces elegans*, Corda, *R. cucurbitarum*, Berk. & Rav., *R. strangulatus*, n. s., as known American members of the genus, and desribes a new genus, *Sigmoideomyces*, upon the species *S. dispiroides*, found upon under side of a moist log, Burbank, east Tennessee. Notes that the genus bears much the same relation to *Œdocephalum* that *Dispira* does to *Aspergillus*. Closes with synopsis of the described species of *Œdocephalum* and *Rhopalomyces*.

240. Weed, C. M. **The scab of wheat heads.** Proc. 11th Ann. Meeting, Society for the Promotion of Agricultural Science, Indianapolis, Indiana, August 18, 19, 1890, pp. 47–48 (issued December, 1890, with figs.). Notes *Fusisporium culmorum*, W. G. Smith, as causing serious damage to the heads of wheat in Ohio.

241. ———. **A second experiment in preventing the injuries of potato blight.** Bull. Ohio Ag. Ex. Sta., second series, Vol. III, No. 8, September, 1890. Gives report of somewhat unsatisfactory experiments against potato blight with use of Bordeaux and ammoniacal copper carbonate solutions. Notes bacterial disease as found by Burrill in Illinois.

242. Wingate, Harold. **Orcadella operculata, Wing. Nouveau Myxomycete.** Revue Mycologique, Toulouse, April, 1890. (November, 1889), No. 46, p. 74. Describes a new family of *Myxomycetes* (*Orcadellaceæ*) consisting of the single species *Orcadella operculata*, found in Fairmount Park, Philadelphia, and also in Maine (Harvey), growing on living trunks of *Quercus rubra*. Considers it to stand in order 4 of Rostafinski after family 13 (*Clathroptychiaceæ*) and unites in a measure the orders *Anemeæ* and *Heterodermieæ*.

GENERAL INDEX.

INDEX TO FUNGI.

[NOTE.—Fungi described in the text are in small capitals, synonyms in italics.]

INDEX TO HOSTS.

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